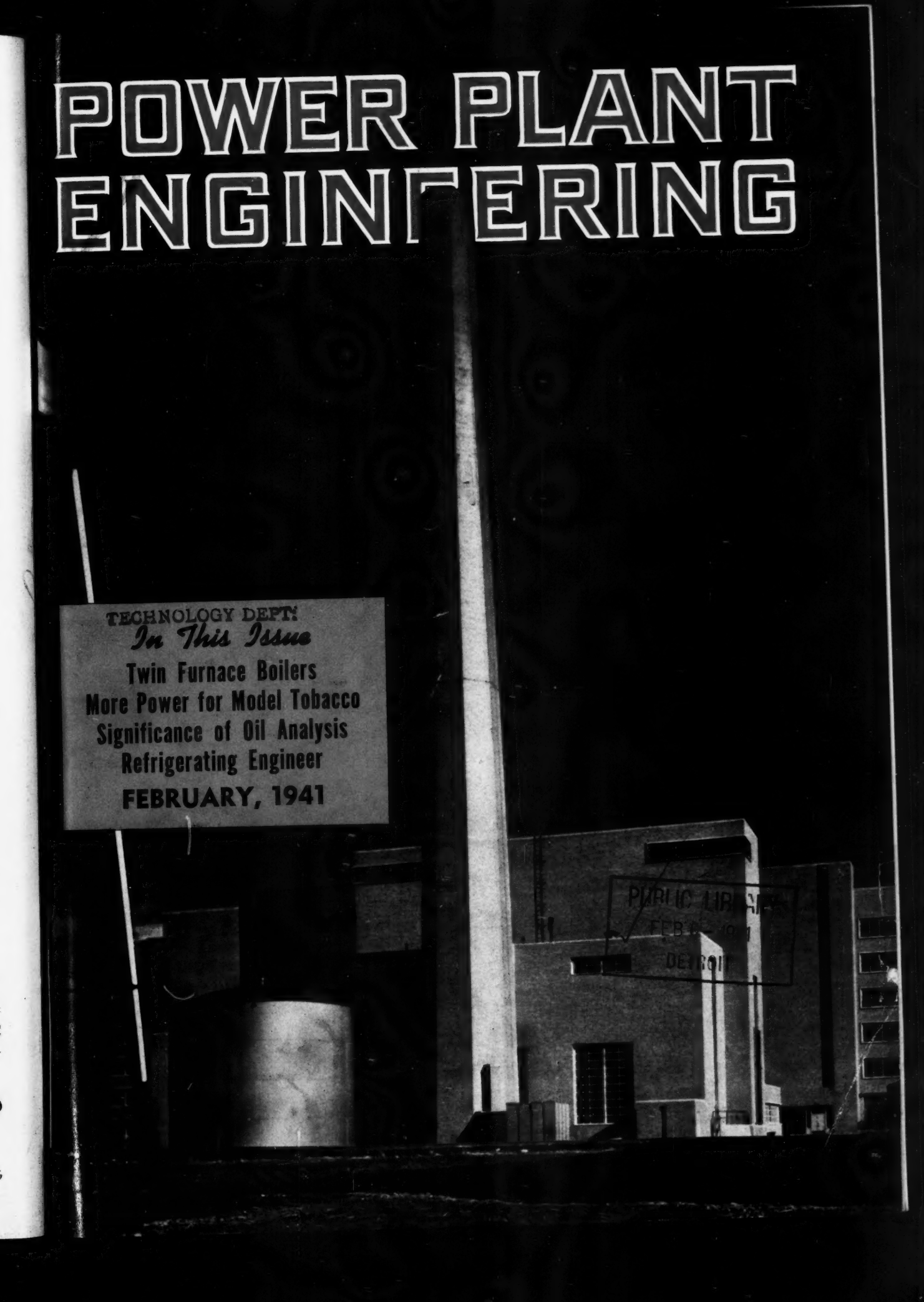
POWER PLANT ENGINEERING



TECHNOLOGY DEPT.

In This Issue

Twin Furnace Boilers
More Power for Model Tobacco
Significance of Oil Analysis
Refrigerating Engineer

FEBRUARY, 1941

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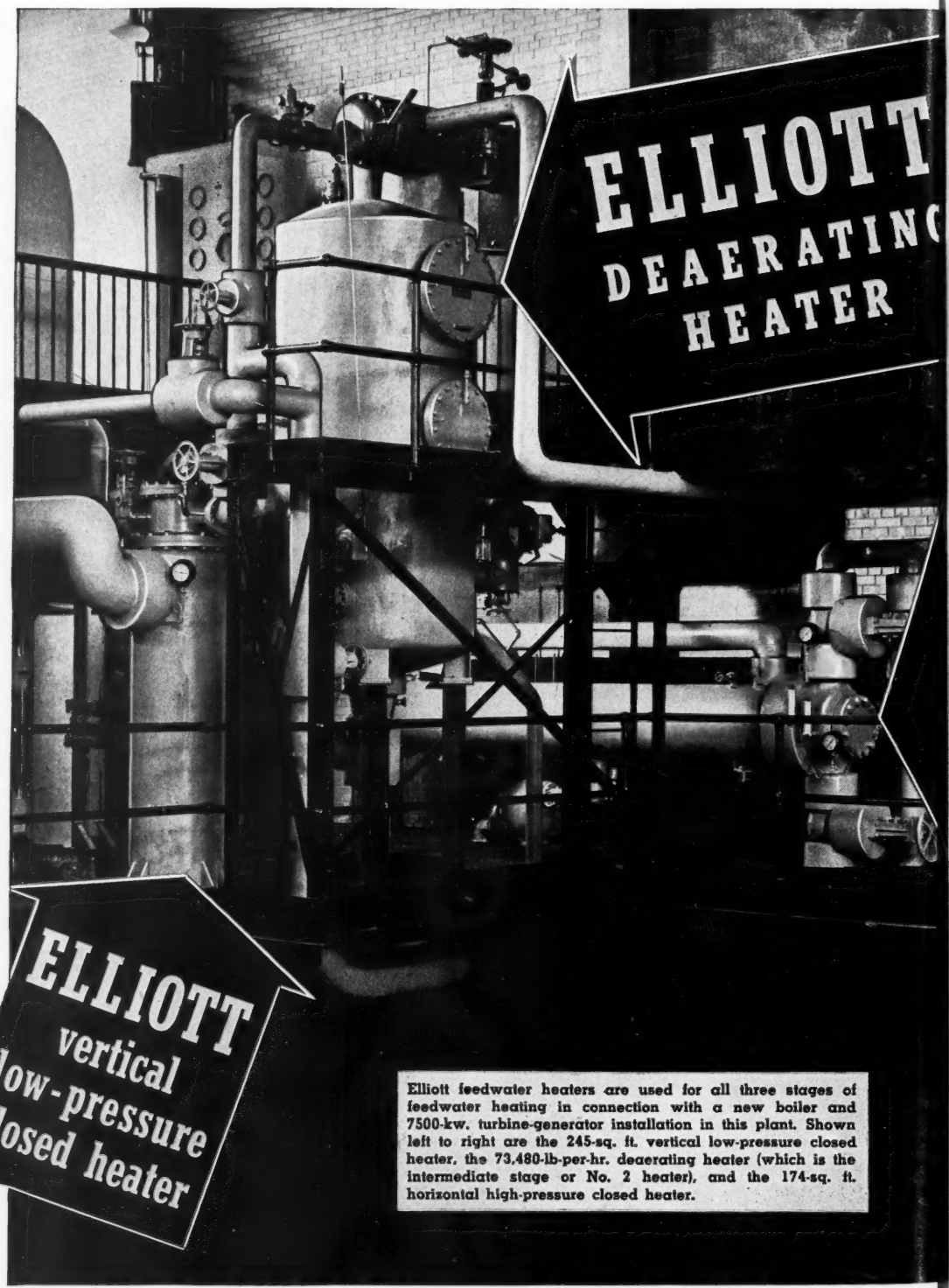

Elliott feedwater heaters are used for all three stages of feedwater heating in connection with a new boiler and 7500-kw. turbine-generator installation in this plant. Shown left to right are the 245-sq. ft. vertical low-pressure closed heater, the 73,480-lb-per-hr. deaerating heater (which is the intermediate stage or No. 2 heater), and the 174-sq. ft. horizontal high-pressure closed heater.

POWER PLANT ENGINEERING

FEBRUARY, 1941
VOLUME 45, NO. 2

Cover: One of America's outstanding industrial groups, the new United States Tobacco Co. plant. Schmidt, Garden & Erikson, architects and engineers, Jean St. Thomas, photographer.

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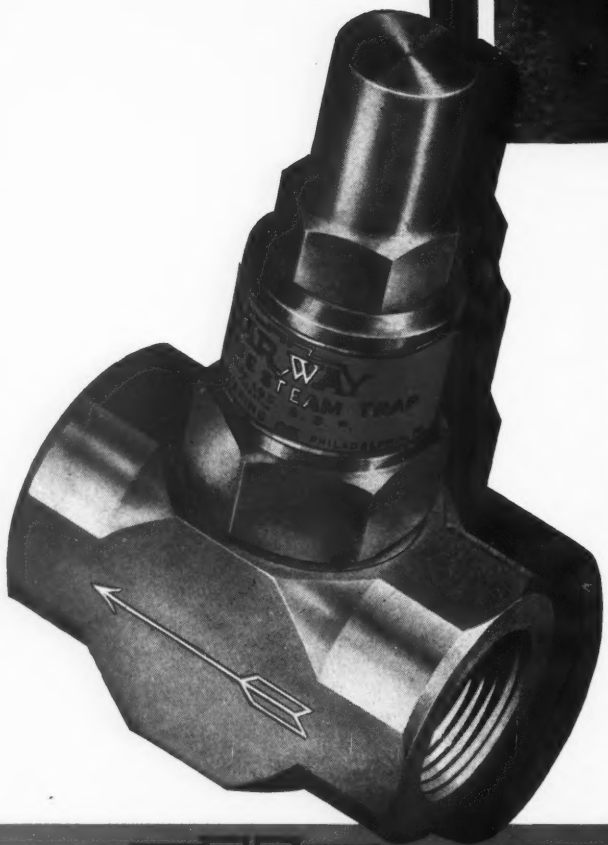
YARWAY
IMPULSE TRAPS
SPEED THE NEWS



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INDUSTRY SPEAKS

IRVING S. OLDS on the PROBLEM of EMERGENCY INDUSTRIES

IN THIS country, where the maintenance of peace always has been regarded as the highest attainment of Government, few manufacturers possess any plant capacity which has been devoted to the production of instruments of war during recent times. A year ago the manufacturer of munitions hardly existed in the United States, outside of the limited production of the Government arsenals. . . .

Despite statements often made to the contrary, the same state of affairs existed in 1917 and 1918. If we should take on belligerency, it will be because public opinion overwhelmingly regards that course as in the best interests of our people, and not because war may be beneficial in the short run to any group of selfish individuals. Certainly no responsible business leader today looks to war as a road to sound or enduring prosperity.

Scope

The scope of our preparedness effort is tremendous. . . . No group of men at Washington or elsewhere, however able and experienced they may be, can accomplish the impossible. Battleships, cruisers, tanks, aircraft, guns and numerous other weapons do not spring into existence over-night. Time—much time—of which we have none to spare, is required for their production. . . . All must . . . do whatever is in his power to reduce this period of time to a minimum.

I am confident that the business men of this country will co-operate fully with the Government in the fulfillment of any restrictive program of priorities or otherwise which may become necessary in the common cause. However, as a step in the promotion of such full co-operation, both they and the general public should at all times be clearly informed as to the necessity for and the reasonableness of the proposed action.

Our national policy should be determined on the basis of three aims, which I regard as primary and essential: first, the early realization of adequate national defense; second, the preservation of our system of free enterprise, so that those who succeed us may enjoy the benefits of our proven economic order; and third, the avoidance of inflation. In the long run each aim is of vital importance.

Post War Problems

If a proper balance can be maintained, the shock of the inevitable readjustment which must follow the present emergency will be greatly lessened. So far as it is humanly possible to do so, defense plans should be formulated after giving careful thought to the after-effects—to the consequence at a time in the future when a more peaceful order will prevail in the world.

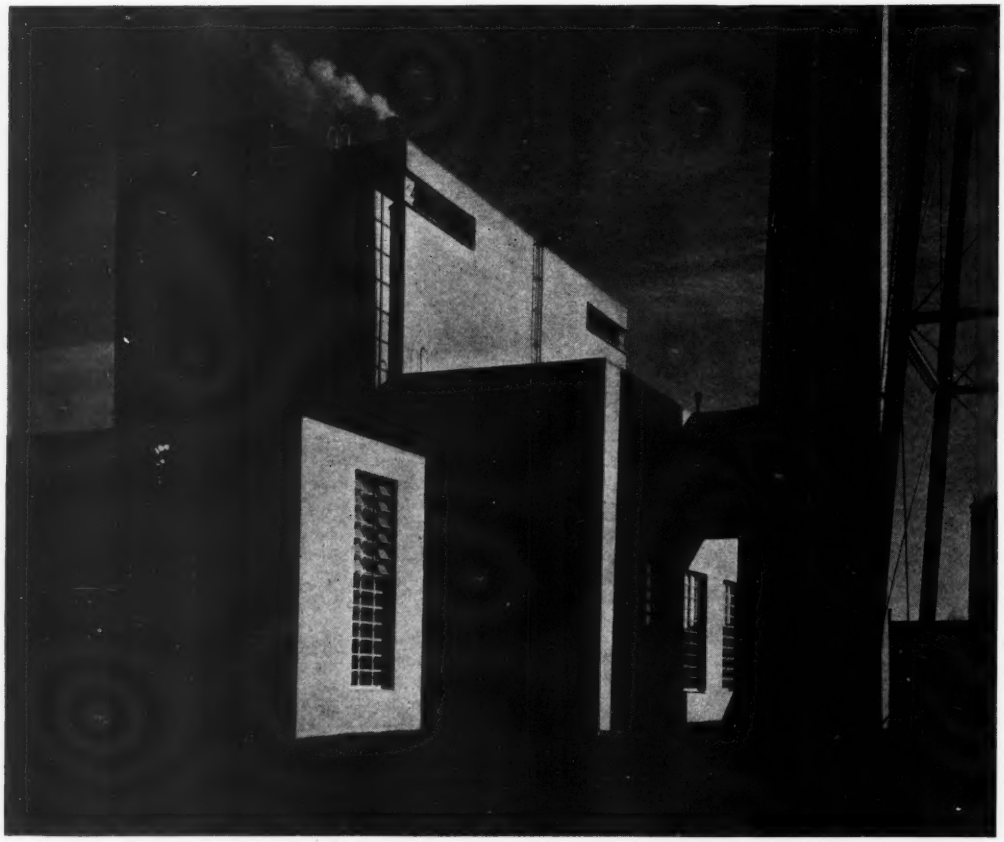
Outlay for special facilities for defense purposes, whether paid for by Government or by industry, should be completely charged off during the emergency period as a part of the cost of the preparedness effort. In these situations there should be no amortization hang-overs.

Industry in the performance of its duty under the defense program should not be called upon to provide at its expense a vast array of new special facilities of a costly nature, which will be of doubtful commercial value at the conclusion of the emergency. It is entirely fitting that facilities of this exceptional character be provided at the cost of the Federal Government, although presently entrusted to private hands for operation on defense orders.

But when the emergency is a thing of the past, these special Government-owned plants and equipment, if not then abandoned or disposed of to private industry, should be held in reserve by the Government for use only in the event of another similar emergency. They should not be utilized by the Government to compete with private business. Our endeavor today is not in the direction of state socialism, but rather is a strenuous attempt to protect our nation and its institutions and our democratic way of life against possible aggression by foreign totalitarian states.

In this endeavor, the perpetuation of our long established system of free private enterprise is essential. This involves the recognition by both Government and the general public of the propriety of business in the public interest earning a fair return commensurate with its investment, its costs, its efforts and its risks.

Irving S. Olds is chairman of the Board of Directors of the United States Steel Corporation, one of the key units of the National Defense program. The steel industry, operating for years at fractional outputs, has of recent months been pushed to the limit and there have been frequent demands for new capacity. These remarks, part of an address delivered at the 47th Annual Banquet of the Illinois Manufacturers Association at Chicago, Dec. 3, are significant. The practical problems discussed will be met frequently during coming months and the way in which they are solved will have a vital bearing on our post war economic system.



MODEL PLANT

AUSTERE simplicity marks the architectural design of this fine new power plant of the U. S. Tobacco Co. at Richmond, Va. Devoid of useless frills its architectural design is essentially functional, yet it is a thing of beauty to the eye. In the early morning sunlight as shown here it presents a study in contrasts that will delight every serious photographer's eye. If the exterior of this plant appeals to the eye, however, so does the interior. As shown in the pages that follow the interior design and arrangement of this plant is as sleek and streamlined as the exterior. Even a casual study of this plant makes one realize how far we have come since the days when the industrial power plant was a dark, grimy hole filled with half naked wretches shovelling coal by hand into blazing hot but inefficient furnaces. In those days the scoop and the slice bar were the symbols of boiler room technique; today the glittering control board serves in their stead. There are times in this war torn world when we are likely to be cynical and deprecate man's so-called progress, but some things at least are better than they used to be. This power plant is one of them.

WITH THE EDITORS

◆**WANDS** . . . The wand in the hands of those skilled in its use is a strange and wonderful tool. In the hands of even a mediocre prestidigitator it makes rabbits jump out of hats and by merely waving one a fairy can transform a purple dragon into a beautiful princess or vice versa. These mysterious rods, however, have been of little use in the hands of ordinary mortals not endowed with hocus-pocus powers—they cannot accomplish even the simplest tricks with them. When an electrical engineer, for example, wants to measure the power in an alternating current circuit, does he use a wand? Not so you can notice it. Instead he hauls forth a weird and fearsome collection of gadgets with wires attached to them and after making sundry connections finally is able to measure the power and even then his results don't check with the electric bill. With a little wand even an ordinary fairy could accomplish the same thing in two shakes of an elf's wing. Do elfs have wings?

◆**ELECTRICIAN NECROMANCY** . . . But now comes Andrew Alford of the International Telephone Development Co. and with a couple of plain metal rods a foot or so in length proceeds to measure not only power, but everything from voltage and frequency to inductance and di-electric breakdown and a dozen other things in high frequency circuits. In some instances the addition of a small ammeter or a tiny neon bulb or even a thermometer and an eye cup is necessary but this is absolutely all the equipment he uses in making these measurements. At ultra high frequencies the accuracy of this absurd collection of rods and eye cups is uncanny. Using two parallel rods and a shorting bar arranged in this fashion

it is easy to measure a capacitance of a fraction of a micro-microfarad by the mere displacement of the shorting bar. Two copper rods and a Christmas tree lamp, and, presto! you have a frequency meter. To those of us brought up in the traditional ways of electrical engineering Mr. Alford's recent talk before the I.R.E. was strangely fascinating, much more so than pulling rabbits out of hats.

◆**STRANGE JUICE** . . . Many other curious things happen at ultra-high frequencies. At 125 million cycles per second, 14,000 volts is an enormous voltage, almost impossible to keep within bounds. It simply will not stay where it belongs; turn your back and it jumps off the wires and goes wandering all over the place. It thumbs its nose at conductors and has no respect for any except the most "high hat" of insulators. Ordinary glass and plastics fail at once. A piece of dry string tied to one of the conductors bursts into flame the instant the power is turned on. The arc-over voltage between points in air is very much reduced. As is well known, the breakdown strength of air at 60 cycles is ordinarily figured at around 10,000 volts per inch. At 65 megacycles, however, an inch gap flashes over at a mere 1700 volts. Those of you who have gotten headaches trying to keep 60 cycle juice where it belongs can thank your lucky stars that you do not have to transmit power at 65 or 100 megacycles. At these frequencies, the current slips off conductors as though they were greased and it will just as soon slide off down an insulator as go on along the conductor. Only the finest polystyrenes can keep it where it belongs.

◆**GULLIBILITY** . . . The belief that "if it appears in print, it must be true" is not adhered to as firmly these days as it was before propaganda became one of the finer arts, but the old habit still persists to a high degree. Only few people very seriously question the things they read.

These thoughts are brought to mind as the consequence of an error that occurred on the feature page of our November issue. This feature was entitled "Once in a Million" and, as may be recalled, described an interesting method of testing and fitting the integrating mechanisms used in Bailey Fluid meters. Consisting of six little counter wheels each carrying numerals from zero to nine on their peripheries, it was pointed out that the first wheel revolved a million times to the sixth wheel's one revolution.

It made an intriguing heading and there was an excellent photograph showing the arrangement used in the tests and most everybody seemed to like the story. As a matter of fact, it was a good article; there was only one thing wrong with it—it was not true. The first wheel does not revolve a million times to the sixth wheel's one revolution; it revolves only a hundred thousand times to the sixth wheel's one.

◆**DUMB EDITORS** . . . The misstatement was, of course, unintentional. It was the fault of one of our dumb editors—the one who is writing these words in fact—and prominently as it was displayed, it got by the entire editorial staff. None of the proofreaders caught the "bull" and even after the magazine went out to the subscribers nobody noticed it—at least they did not tell us if they did. Nobody except one.

◆**FRY'S EAGLE EYE** . . . That one person was E. M. Fry of the Standard Oil Development Company at Bayway, N. J. Apparently, Mr. Fry takes nothing for granted. His eagle eye soon penetrated below the sensationalism of the headlines to the mathematical fallacy on which the whole structure of the article rested so precariously. His slide rule did the rest, and then with one swift telephone call to our New York office he upset our equanimity. We are much chagrined.

◆**T.V.A. and A.V.A.** . . . Regionalism, in which natural boundaries assume the dominant role, played an important part in the early and medieval days. As means of communication improved, particularly after the industrial revolution, the famous city-states of that era gave way to more formidable combinations or political divisions based on military force rather than economic considerations.

The play of political forces to a large extent determined the subdivision of our own country by state and county lines, arbitrarily determined with little relation to natural boundaries. Certain problems, including development of natural resources, flood control, etc., are difficult to handle under several arbitrary political divisions. The first widespread attempt at regional development with control transcending state jurisdiction was the T.V.A.

In 1937 an attempt to blanket the nation with eight regional districts failed, as it deserved to do, not because the idea is necessarily unsound, but because the proposed bill encroached unduly on both state and private rights.

◆**LATEST AUTHORITY** . . . The latest extension of regional development, introduced by identical bills in both houses on Jan. 10, is the Arkansas Valley Authority covering over 308,000 sq. mi. drained by the White, St. Francis, Arkansas and Red Rivers in eight states from Arkansas to Colorado. Like its predecessor, it is based primarily on power and flood control, tying together a score or more of smaller projects already constructed or under construction by various federal agencies and involving three new multiple purpose dam-reservoirs.

Careful local and national planning is undoubtedly necessary if the resources of our nation are to be utilized most advantageously. Regionalism as an instrument of national policy offers possibilities, yet the T.V.A. and less complete experiments such as the Columbia, Colorado, Missouri and Central Valley developments have not yet conclusively demonstrated either success or failure.

Whether the new bills are a sincere attempt at regional planning or whether they incorporate the undesirable features of the 1937 attempt to gain a stranglehold on all industry under the guise of regional planning is as yet unknown. The emphasis placed on power development as a "yardstick" indicates that they will bear close scrutiny.

MORE

Photographs
By
Jean St. Thomas

Fig. 1. Outlined against the sky, the full beauty of the plant is apparent. In the immediate foreground are the shops, beyond them the pump and engine rooms. The bleak outline of the coal bunkers is effectively broken up by windows at diagonal corners and by the cooling tower which forms an extension at the right hand side. At the extreme left is one corner of the warehouse at the right a corner of the six story air conditioned factory shown in front view by Fig. 7. Additional views from the other side are shown on page 42 and on the front cover

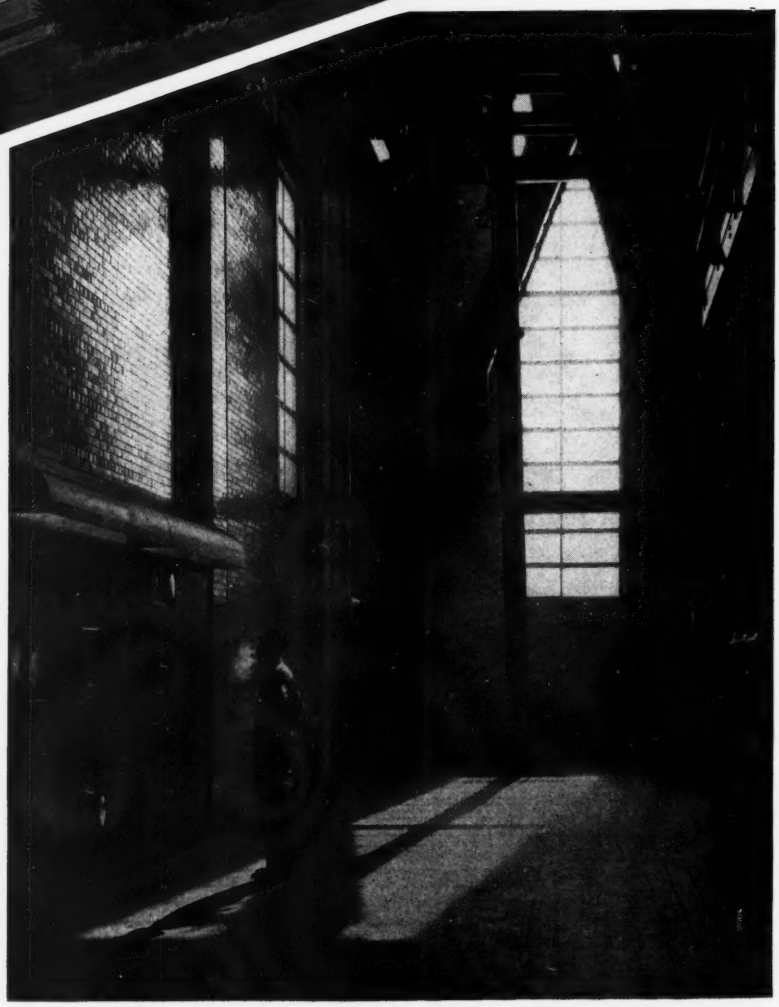


Fig. 2. (Right) Walls and boiler settings are of glazed brick and floors of quarry tile. The coal handling system is dust proof and the boilers automatically controlled. The back of the boiler control panel at the left is closed, but opens up into the pump room on the opposite side of the wall to give full accessibility for repair and maintenance

POWER FOR MODEL

"Did you say Model?" Yes, Sir! We certainly did! Model and Dill's Best Tobaccos have a new home in the Sunny South near Richmond. "Nothing but the best for the Best" was taken literally by architects and engineers resulting in an unusual group of industrial buildings with a streamlined power plant—modern, conforming to the general architectural style, yet functional, flexible and one of the most completely centralized small plants yet built. The author writes with an engineer's natural reticence and modesty so you'll have to read carefully, with close attention to the illustrations, to avoid skipping the finer design points

By GERALD C. DITTMAN
Schmidt, Garden & Erikson
Chicago, Ill.

THE UNITED STATES TOBACCO CO., makers of pipe smoking and chewing tobacco, realized a short time ago that their sale of MODEL and DILL'S BEST smoking tobacco was exceeding their expectations and in order to meet the sales' demand steps would have to be taken to enlarge their manufacturing facilities.

Their plant, located in the heart of Richmond, Va., was somewhat over 40 yr. old and had been added to from time to time, with the result that there was no further space available for expansion. A new site was found and a large plot of ground purchased just outside the city limits. A complete new pipe smoking tobacco manufacturing plant has been constructed there consisting of a complete new set of tobacco warehouses, a six story air conditioned factory approximately 100 by 350 ft. in size and a complete new isolated power plant.

The power plant in brief consists of two boilers, two engine generators, two refrigerating units complete with all pumps, conveying equipment and other appurtenances necessary for fully complete automatic operation. Boilers are B. & W. straight tube with water-cooled bridge walls. Each 637 hp. boiler is designed for 200 per cent continuous operation with a maximum of 250 per cent rating for 4 hr. periods. Over deck superheaters are provided giving a final steam condition of 175 lb. ga. pressure with 125 deg. F. superheat (total temperature 540 deg. at 200 per cent rating.) Boilers are enclosed in sectionally supported insulated air-cooled walls provided with face brick casing.

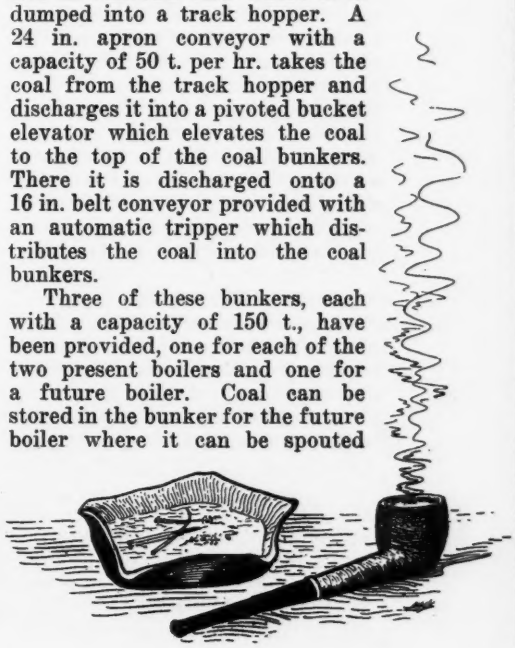
It was contemplated to burn a good grade of West Virginia coal having a heat content of approximately 14,500 B.t.u. per lb. with a moisture content of 2.7 per cent and containing 5 per cent ash. The boiler is to operate at approximately maximum rating for 40 hours a week, the balance of the time the load on the boiler will be only 10 per cent of this amount. In order to take care of such load swings, Stowe Stokers were chosen. These stokers consist of moving and stationary grates, and are provided with dampers so that approximately 60 per cent of the grate area can be dampened off for night operation.

One forced draft fan has been provided for each boiler which is to be used when load on boiler is 30,000 lb. per hr. or over. On lower loads natural draft from a 200 ft. stack, 8 ft. in diam. is sufficient. Inlet vanes are used on the forced draft fans for controlling the air to the fan. Over fire air is supplied to each boiler by a separate small motor-driven fan located on the side of each boiler. Preheated air is taken from the air space over the arch and is admitted to the boiler through nozzles located in the throat of the arch.

Dust Tight Coal System

Coal is received at the plant site in railroad cars where it is dumped into a track hopper. A 24 in. apron conveyor with a capacity of 50 t. per hr. takes the coal from the track hopper and discharges it into a pivoted bucket elevator which elevates the coal to the top of the coal bunkers. There it is discharged onto a 16 in. belt conveyor provided with an automatic tripper which distributes the coal into the coal bunkers.

Three of these bunkers, each with a capacity of 150 t., have been provided, one for each of the two present boilers and one for a future boiler. Coal can be stored in the bunker for the future boiler where it can be spouted



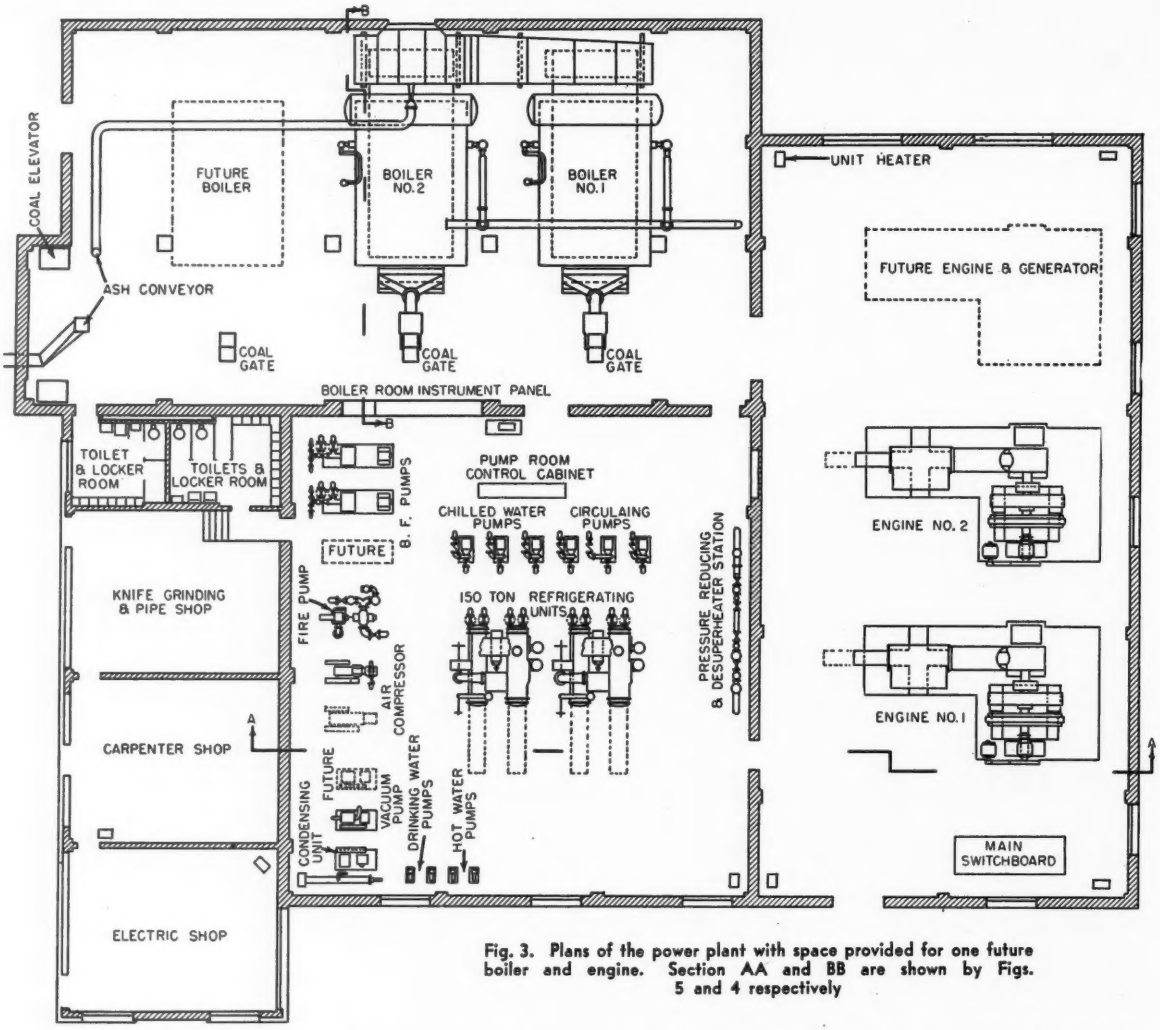


Fig. 3. Plans of the power plant with space provided for one future boiler and engine. Section AA and BB are shown by Figs. 5 and 4 respectively

onto the pivoted bucket elevator in case of emergency and re-distributed into the bunkers for the present boilers. From the coal bunkers the coal passes through a coal valve, coal scale, spout and then through a Stock distributor located on top of the stoker hopper, the entire system being dust tight.

The entire system of coal handling equipment is electrically interlocked with sequence type control which automatically shuts down the conveyor system in case of failure of any one of the various conveyor motors.

Ashes are removed in the basement at the back of the boilers by a Nuveyor ash handling system. Each boiler has two large ash doors from which ashes are raked into intake tees, carried into a large receiver and dropped into the top of an ash storage bin at the rate of 10 t. per hr. From the 80 t. ash storage bin the ashes are spouted into trucks and carried away. From the sifting hopper on the back of the boilers between the second and third pass, special gates have been provided for taking the fly ash from this point and discharging them automatically into the Nuveyor system.

Power Generation

For driving the generators, two Skinner Unaflow engines are used each directly connected to G.E. 400 kw. generator. Engines are designed for 175 lb. ga. steam at 540 deg. F. temperature. Either or both of the engines exhaust at 5 lb. ga. back pressure, or, into a condenser operating at 26 in. vacuum. During the summer months one engine will exhaust into two 150 hp. low pressure Terry turbines directly connected to Carrier refrigerating units while the other engine will supply necessary 5 lb. steam for factory processing. The low pressure turbines will operate at 7500 r.p.m. and will exhaust into a surface condenser at 26 in. vacuum.

Piping connections have been so arranged that during the winter months when the L. P. refrigerating turbines are out of service, one engine can be operated condensing while the other supplies 5 lb. steam for factory processing and heating. In case the demand for L. P. steam exceeds the amount supplied by the engines, Spence reducing valves and desuperheating equipment has been provided to automatically supply the demand. A considerable amount of 125 lb. sat. steam is required for factory processing. This steam is taken from the high pressure header, reduced and desuperheated to the exact pressure and temperature required.

A C. H. Wheeler cooling tower located on the roof of engine room supplies 1250 g.p.m. of water to the condenser. During the summer months, however, the cooling water

circulates through the refrigerating unit first and then through the steam condenser before going back to the cooling tower.

In order to insure clean L. P. steam for factory process work, free from oil, etc., a large Cochrane receiver type four-compartment oil separator is provided in the exhaust from each engine. Each separator is 5 ft., 6 in. in diam. by 14 ft. long and is provided with spray nozzles, steel wool filter and suitable cleaning device. As a further guard to keep all traces of oil out of the boilers, a large open drain tank has been provided in the basement into which all low pressures, drains, etc., together with condensate from surface condenser are collected. From this tank drains are pumped through a special Carborundum oil filter and discharged directly into deaerating open feedwater heater.

Two Worthington horizontal duplex, outside end-packed pot valve boiler feed pumps provided with differential excess pressure governors, supply the boilers with feedwater through Copes automatic feedwater regulators.

Air Conditioning

In order to properly condition the tobacco for manufacture, a complete system of air conditioning is provided in the factory. To supply the chilled water for the air conditioning, two 150 t. centrifugal refrigerating units are provided in the pump room. Each unit is directly connected to and driven by a Terry 150 hp. low pressure turbine designed to operate with 5 lb. steam pressure and exhausting into surface condenser at 26 in. vacuum. Normal turbine operating speed is 7500 r.p.m., each unit is equipped with a constant speed and overspeed governor together with spe-

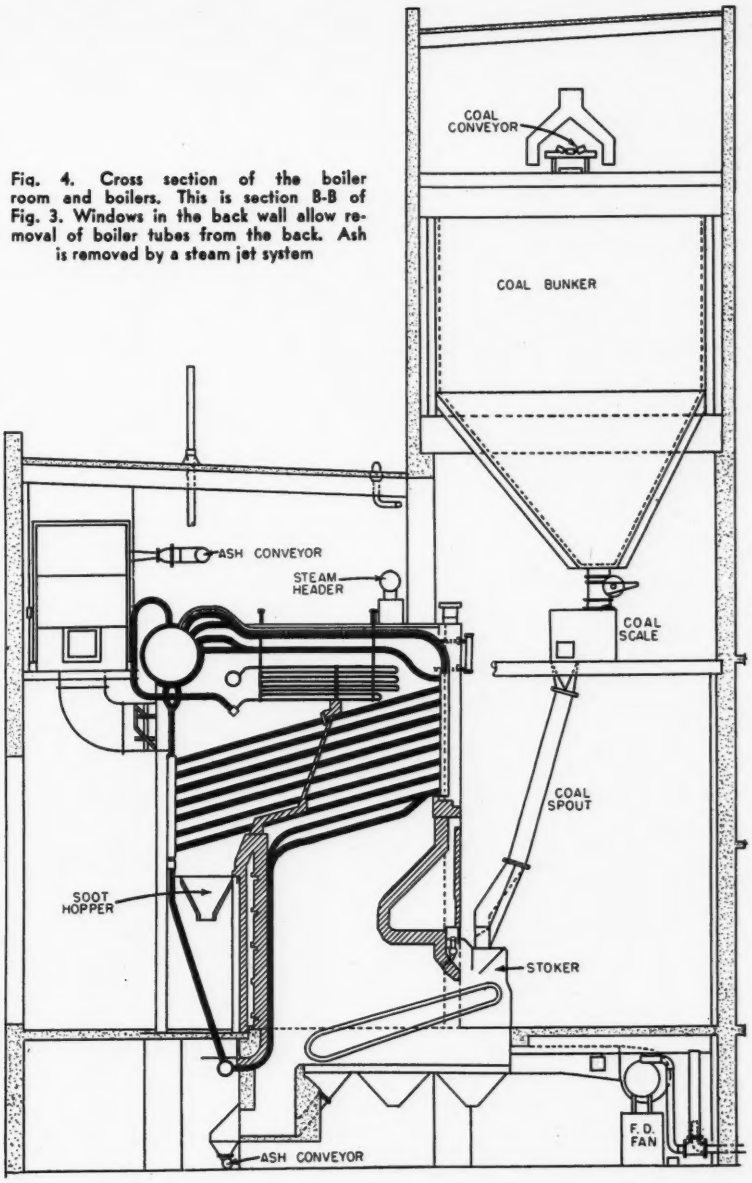


Fig. 4. Cross section of the boiler room and boilers. This is section B-B of Fig. 3. Windows in the back wall allow removal of boiler tubes from the back. Ash is removed by a steam jet system

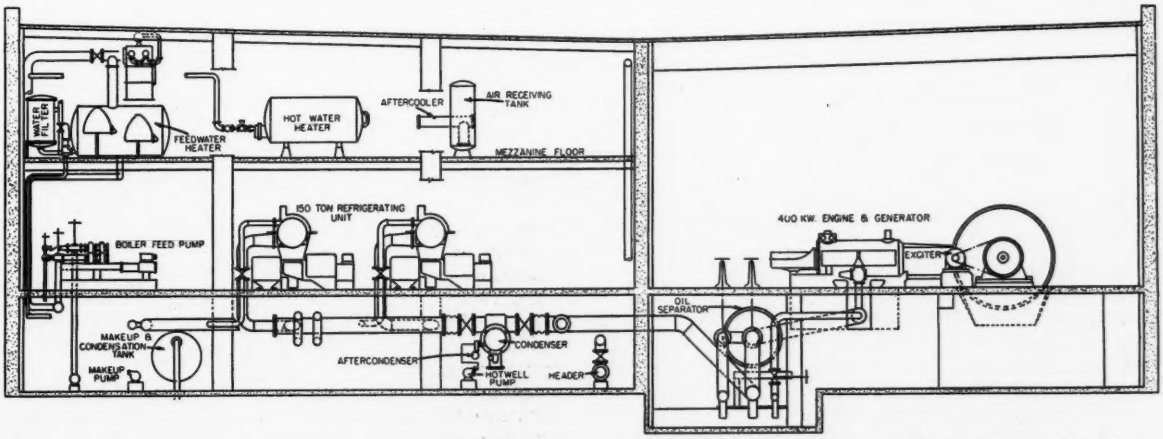


Fig. 5. Section AA of Fig. 3 showing the pump and engine room arrangements. All auxiliaries and air conditioning units are located in the pump room with all motors controlled from a central panel

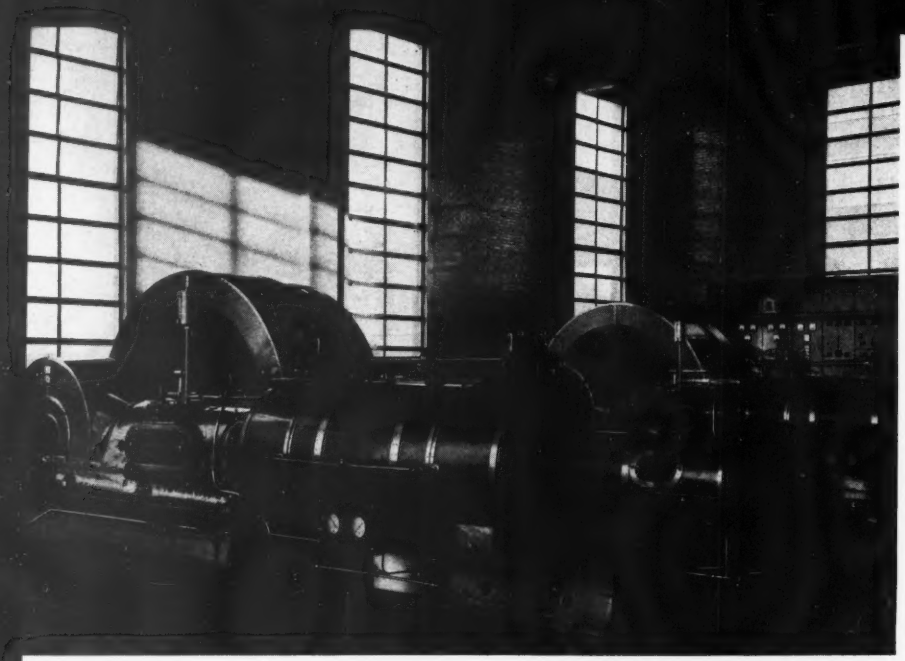
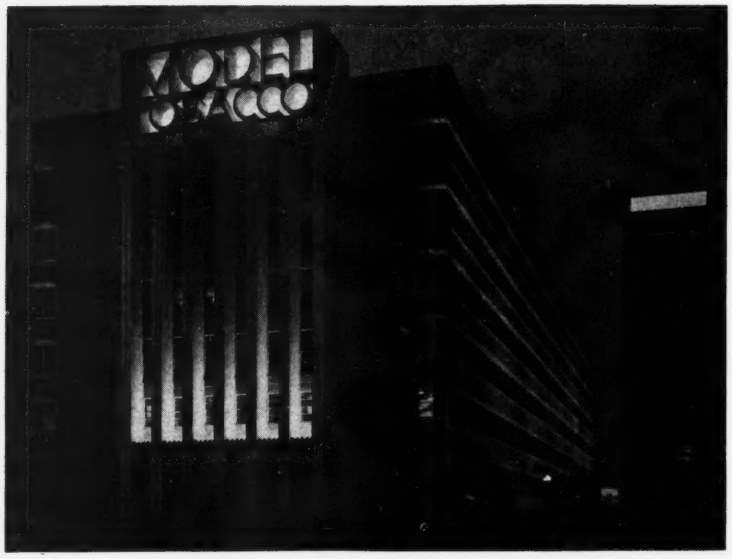


Fig. 6. Two 400-kw. engine generator sets are installed to be operated condensing or non-condensing depending on steam requirements. All steam and exhaust piping is below the floor with valves controlled by hand wheels from the operating floor. The switchboard in the background has eight panels, including three generator panels one of which is a spare provided for a future generator

Fig. 7. Front view of the six story factory building with the flood lights on. This building is air-conditioned by two low pressure steam turbine driven centrifugal refrigeration units of 150 t. each and located in the pump room of the power plant



cial speed governor which controls the speed of the unit by the temperature of the return chilled water. Suitable vacuum pumps, air compressors, circulating pumps, fire pump, and drinking water cooling unit to amply supply all the factory's requirements have been provided in the pump room.

Directly in front of the boiler in the boiler room, recessed into the wall, is located a large instrument panel approximately 19 ft., 6 in. long by 7 ft., 6 in. wide. On this panel is located all the instruments required for the operation of each boiler together with all push buttons for controlling stoker fan motors, etc. In the center of the panel are located various recorders, indicating gages, temperature recorders, and other instruments for the various steam, water and air lines, etc., throughout the power plant.

Two electric generators are installed in the engine room, each one rated at 400 kw. at 80 per cent power factor or 500 kv-a. and designed to operate at 480 v., 3 ph., 60 cy. Each unit is provided with a separate belt-driven exciter rated at 15 kw. at 125 v.

Electrical Services

For current distribution a nine-panel switchboard has been provided consisting of one synchronizing, two generators, one future, one totalizing, and four distributor panels. This G.E. switchboard is of the dead-front type construction with provisions for control at the switchboard. Air circuit breakers are provided on the panel for controlling the 440 v. power lines to factory and power house services and for the lighting transformer circuit. To take care of the lighting three 200 kv-a. Pyranol-filled transformers are installed, having connected delta on the primary side and star on the secondary side. They are to be operated in a three-phase bank to transform 440 v., 3 ph., 60 cy. to 120/208 v., 3 ph., 4 wire. A secondary bus is carried in back of the main switchboard from which lighting breakers distribute current to various parts of the factory, warehouses, and power plant.

A power distribution center is located in the pump room onto which is mounted swing-way type of breaker for each individual motor in the power house. A large electrical control cabinet is located in the center of the pump room. On the front of the cabinet flush mounted push buttons are located with indicating lights for controlling each motor in pump room. Magnetic starters for individual motors are located within the cubicle.

In keeping with the factory building extreme care has been exercised in making the power house a building of beauty as well as utility. The entire exterior is of face brick as well as the octagonal stack. The interior of the building is glazed brick and the floors of the boiler, pump, and engine room are of quarry tile. Electric and pipe shops are also provided adjacent to the power house.

All architectural and engineering work was done by the firm of Schmidt, Garden & Erikson of Chicago who worked very closely with T. A. Clark, Chief Engineer of the United States Tobacco Co., who furnished all information and data necessary for the execution of this project.

LIST OF PRINCIPAL EQUIPMENT AT THE U. S. TOBACCO PLANT

Boilers— The Babcock & Wilcox Co.
Superheaters— The Babcock & Wilcox Co.
Water Walls— The Babcock & Wilcox Co.
Suspended Insulated Walls— American Arch Co.
Stokers (Stowe)— Johnson & Jennings Co.
Forced Draft Fans— Clarage Fan Co.
Over Fire Air Fans— Clarage Fan Co.
Deaerating Feedwater Heater— Cochrane Corp.
Oil Separators— Cochrane Corp.
Relief Valves (Atmospheric)— Cochrane Corp.
Boiler Feed Pumps— Worthington Pump & Mach. Corp.
Fire Pump— Worthington Pump & Mach. Corp.
Main and Auxiliary Air Comp.— Worthington Pump & Mach. Corp.
Process Vacuum Pump—Ingersoll-Rand Co.
Misc. Circulating Pumps— Ingersoll-Rand Co.
Refrigerating Units— Carrier Corp.
Refrig. Turbine Drives— The Terry Steam Turbine Co.
Coal Conveying Equipment— Link-Belt Co.
Coal Valves— Stock Eng. Co.
Coal Distributors— Stock Eng. Co.
Ash Handling System— United Conveyor Corp.
Steam Condenser— C. H. Wheeler Mfg. Co.
Cooling Tower— C. H. Wheeler Mfg. Co.
Engines— Skinner Engine Co.
Generators— General Electric Co.
Switchboard— General Electric Co.
Magnetic Starters— General Electric Co.
Reducing Valves & Desuperheater— Spence Eng. Co.
Oil Filter— Adams Filter Co.
Gate Valves— The Lunkenheimer Co.
Flow Meters— Republic Flow Meters Corp.
Steam-Flow Air-Flow Meters— Bailey Meter Co.
Combustion Control System— Bailey Meter Co.
Draft Gages—Republic Flow Meters Corp.
Gages (Duragauges), Thermometers and Relief Valves— Consolidated Ashcroft Hancock Co.
Feedwater Governors & Regulator (Copes)— Northern Equipment Co.
Transformers— General Electric Co.
Temperature Recorders— Leeds & Northrup Co.
CO_2 Recorders— Leeds & Northrup Co.

CONTRACTORS

General — John Felmley Co.
Steamfitting — William A. Pope Co.
Plumbing — Carle-Boehling Co.
Electrical — Chewning & Wilmer
Air Conditioning — Carrier Corp.
Sprinkler — Grinnell Co.

III. SIGNIFICANCE OF AN OIL ANALYSIS

GREASES And Their Application

In spite of the importance of grease as a lubricant, the evaluation of significant properties and characteristics from test data lags far behind that of lubricating oils.[1] A number of test procedures have, however, been developed and offer some guidance to the prospective user in making intelligent selections.

By Harold E. Rose

DUE TO THE nature and composition of greases and the difficulty of evaluating intangible characteristics, many of the testing methods employed are the result of general experience rather than standardized laboratory methods. Some of the intangibles are: structure, odor, color, emulsibility, elasticity, oxidation and storage stability. Methods for the determination of consistency, melting or dropping points and chemical analysis have, however, been standardized by the American Society For Testing Materials.

This society has defined a grease as "a combination of a petroleum product and a soap or a mixture of soaps, suitable for certain types of lubrication." Three ingredients are required in the manufacture of most greases: mineral oil, animal or vegetable fat and an alkali; the latter two components forming the soap. By varying the method of manufacture and composition, a resultant product may be fluid, semi-fluid or solid; any color desired and may contain such additives as yarn, talc, mica, sulphur, graphite, etc. Each varied product is an effort towards the lubrication of a specific problem.

A brief summary of the characteristics of the principal types of grease is offered to acquaint those not familiar with grease products. Such materials are often referred to as soft greases, hard greases, axle greases, cup greases, etc., but the manufacture classifies them as to soap base. That is, soda soap greases, lime base, mixed bases and aluminum soap greases. Such a classification has merit since it predisposes certain properties.

Lime and Soap Bases

The so-called axle and cup greases are lime base products, and are produced by cooking together lime, water and a selected fat. After saponification of the fat is completed and the lime or calcium soap thus formed, mineral oil is added and processing continued until the desired effect is secured. Lime base greases as a class are water resistant, smooth, have a tendency toward stickiness, separate at elevated temperatures and have a melting point of approximately 175 deg. F. They have a range of consistency from a fluid to that of a fairly hard product.

Soda soap greases are prepared in practically the same manner as lime base greases, caustic soda being substituted for lime. However, two types can be produced: (1) those containing free water; and (2) those practically free of water. Soda soap greases are typically fibrous and stringy in structure. They are more adhesive than lime base products and withstand much higher temperatures without separating. They are not water resistant, but lend themselves well to remelting and moulding. They possess a melting point of approximately 400 deg. F. Soda soap greases have a wide range of consistency—ranging from soft ball-bearing products to hard brick or cake greases. Driving journal greases molded to fit the journal box is a typical example of rigidity obtainable.

[1]This is the third part of a series by the same author on "The Significance of an Oil Analysis". The other two parts appeared on page 57 of the October and page 90 of the November, 1940 issues.

Mixed base greases, as the term indicates, are the incorporation of two bases. The predominate soap governs the characteristic, modified to some extent by the presence of the secondary soap. Thus, the addition of a lime soap to soda soap has the effect of shortening the fiber structure retarding the change in consistency on working, and making the grease more resistant to water. Soda and aluminum soaps may be added to lime soap in order to produce a grease more resistant to separation at higher temperatures. They are generally prepared to combat unusual service requirements.

Aluminum soap greases are a distinct type, having only a few special uses. They are prepared by a "double decomposition" method in which the soda soap is made in one step, and the aluminum soap in a second step. The aluminum soap is then subjected to a treating process, added to the mineral oil and the processing completed. The resulting grease is unusually clear and transparent, varying from a gel to a viscous, stringy structure. They are very cohesive and water resistant. They melt at approximately 250 deg. F. and they find use as pressure gun lubricants.

While a knowledge of the physical characteristics of greases is extremely useful in determining quality and suitability, intangible properties must be considered and often can only be determined by actual service. This is typified by bearing lubrication where one grease produces lower operating temperatures than another. Such a factor is the more logical reason for final selection than physical or chemical test data signifying ability. Test methods provide information relative to inherent characteristics and general suitability.

Color and Odor

There is no more logic in judging the quality of a grease by its color than in estimating its value on the basis of the container in which it is packaged. Color, however, may offer a clue to the type of mineral oil employed in manufacture; black or dark greases generally indicate heavy cylinder stocks, while light-colored products suggest filtered or bright oils. Frequently, greases are colored with dyes for the purpose of identification.

Many of the fats used in grease manufacture possess disagreeable odors, hence the use of perfume as a means of disguise. Scenting materials used for identification or in masking products for food industry use are justified. However, inexpensive or general-purpose greases which are highly perfumed should be viewed with suspicion since it may be the masking of rancid fats. Greases made from such fats deteriorate rapidly and usually develop a marked increase in acidity with storage.

Texture and Consistency

Texture refers to the structure of a grease and is reported by the use of such terms as: fibrous, smooth, spongy, etc. It is a characteristic of the basic soap employed and is related to service requirements. There are no quantitative methods available for judging this property.

The consistency of a grease may be likened to the viscosity of an oil; it is a measurement of "fluidity." It is of prime importance since it provides a simple guide to the suitability of a product for a particular service. A product too heavy may result in channeling and starved lubrication, while one too light will fail to withstand operating temperatures. The latter results in leakage and excessive wear. Consistency is also one of the governing factors in consumption.

A number of methods have been proposed for measuring consistency, however the A.S.T.M. Penetrometer provides a numerical expression of consistency. This procedure is covered in A.S.T.M. Method D 217-38T, Test for (Tentative) Consistency of Lubricating Greases and Petrolatum. The method embodies the use of a double-pitch cone of specified size and weight which is supported in an asphalt-penetration tester. The cone is allowed to fall into the grease sample and the depth of penetration measured in millimeters. It is this measurement which provides the numerical values.

Results may be reported on the "unworked" and "worked" penetration. An "unworked" sample represents the grease sample as present in the original container. A "worked" sample is one in which the grease has been subjected to the working action of 60 double strokes of a perforated plunger in a standard A.S.T.M. Grease Worker. The need for both determinations is found in the fact that certain greases show marked changes in consistency after initial working.

It is unfortunate that no standardized limits between penetration and commercial grade numbers has been established. This results in a condition in which a Number 2 grease marketed by one manufactures may be a Number 5 to another or Number 00 to a third. Since a universal penetration range for the various grades does not exist, grade numbers are of no importance to the user. A system of classification such as is utilized in designating motor oils would aid materially.

Melting and dropping points are often used synonymously, yet such usage is not correct since greases do not have a true melting point. A melting point implies a definite change from a solid to a liquid state; greases gradually soften as the temperature increases until there is a complete separation of oil and soap. For this reason laboratory tests usually indicate the dropping point of the grease rather than the melting point. As a general rule the melting point is a few degrees less than the dropping point —all results being reported in degrees Fahrenheit.

Dropping Point

Grease manufacturers have failed to agree upon a standardized method for determining the dropping point, thus giving rise to a vast number of methods employed in measuring this characteristic. To further complicate the existing condition, there appears to be little or no relationship between the results obtained by the various methods. To the user, therefore, dropping point results are of little value unless the method employed is so stated. A brief description of some of the more commonly used methods are as follows:

MERCURY METHOD: This method is well adapted to hard greases. A 1/16 in. cube of grease is placed on the surface of clean mercury contained in a 25 c.c. porcelain crucible, and heated until the grease begins to melt. At this point the temperature of the mercury bath is determined by use of a thermometer and the results recorded as the melting point. Such a test might easily be determined in the plant since little equipment is required. This method, however, must not be applied to soda soap materials as they tend to flatten out rather than melt down.

CAPILLARY METHOD: There are variations of this method but they are essentially the same. A capillary tube of selected diameter and about 6 in. long with both ends open is

dipped into a sample of the melted grease and about ½ in. of the grease allowed to rise in the tube. Several hours are required for solidification of the grease, after which the tube is placed in an oil bath and heated until the grease remelts and rises up into the tube. The temperature of the bath at this point is considered the melting point.

UBBELOHDE METHOD: The modified Ubbelohde Method has been given considerable attention due to simplicity of apparatus and reproducibility of results. The method employs a thermometer equipped with a metal ring, the lower portion of the ring having a brass cup attached with a small opening in the bottom. The cup is filled with grease and the assembly fitted into a large test tube. The assembly is held in place in the test tube by means of a slotted cork. The tube is then placed in an oil bath and heated at an uniform rate. The temperature at which the first drop falls from the small opening in the brass cup is taken as the dropping point. The method is applicable to most types of grease.

This determination is of the utmost importance to the user of grease products, particularly where the application is operation of equipment functioning at elevated temperatures. It is a major factor in determining the rate of consumption. Obviously, a bearing operating at 300 deg. F. should not be lubricated with a grease having a dropping point of 250 deg. F. The determination is also of value when utilized in checking the uniformity of a product. Intelligent grease selection can only be made after careful study of operating conditions and temperatures, and in this latter phase information relative to dropping points becomes essential.

Channel Tests

In certain low temperature applications, the channeling tendency of a grease is important. Unfortunately, a standard procedure has not been adopted for evaluating this characteristic. Numerous methods have been devised such as measuring the time required for a steel ball to penetrate a given quantity of grease at specified temperatures; forcing a metal rod through the chilled grease in a horizontal direction and observing the rate at which the channel thus formed is closed; others employ mechanical gear equipment. Unless the test method approaches conditions similar to those in operative service, the results are of little value to the user. Oftentimes the user must resort to the "trial and error" method.

Chemical Analysis

A chemical analysis of a grease is of little value in estimating performance, since two products may show identical composition and yet vary widely in service behavior and storage stability. The analysis is indispensable to the manufacturer who requires the information for process control. Items determined in an analysis may include: ash, fillers, type and percentage of soap, acids, alkali, type and viscosity of mineral oil, unsaponified matter, pour point of mineral oil, water content and fats used. The user may employ an analysis to advantage where a definite soap base is specified or when wide variations between shipments are not desirable.

WHY?

A CRITICAL ANALYSIS

Has engineering design progressed as rapidly as it might have if engineers had critically examined each detail? The author thinks not—and uses the surface condenser as a case study

By WILLIAM M. KENNEDY

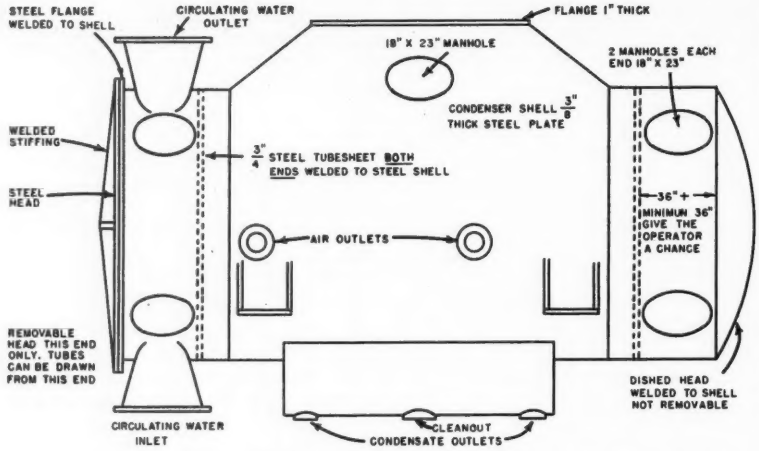
General Manager
Condenser Service and Engineering Co.
Hoboken, N. J.

WHY? We encourage children in the use of the word because through it they learn. The man who would be the best engineer in the least time in any line of endeavor is the one who is a constant question mark, one who gets the facts by constantly questioning, Why? He is the man who is open to any and all suggestions, who, after he learns lots and lots, still has an open mind, still asks why, who knows he knows things, but knows there is more to know. He knows that to know more he must continue to be a "why," one who will accept a modern engineering development as only a step in progress, regardless of how much of an improvement it may be over existing standards. Applied to condensers it is an indication that many improvements are possible and probably should now be milestones instead of future development. Why?

It is appreciated that no one group of materials or arrangements in design can cover the complete requirements of each job. The design shown here will fully satisfy a large group of users throughout the country and represents real economy. The details were developed principally from the ideas of one of the country's outstanding progressive power plant engineers, who did give a definite reason for every part and each detail of the entire design and they are all practical. We don't, however, say if enough why's are asked, that it cannot be improved. We feel and know that it can be; but let's consider it as Today's, not Tomorrow's, step in progress.

Refer to the condenser. It is intended for fresh water service, which covers a large proportion of our inland condensers. This design is decidedly economical and entirely practical, and the most important consideration is you do not pay for something unnecessary — as with heavy cast iron shells for so many years.

The entire shell is of welded steel, in one piece, from one end to the other. The one head is located in the end from which tubes are drawn when retubing. Tube sheets are steel welded into the shell. The steel shell itself forms the water boxes. From the end of the condenser, opposite the end from which tubes would be drawn, there is no removable head. There are no manholes in the head at either end. There are four large size manholes


STEEL FLANGE WELDED TO SHELL
CIRCULATING WATER OUTLET
FLANGE 1" THICK
18" X 23" MANHOLE
2 MANHOLES EACH END 18" X 23"
CONDENSER SHELL 3/8" THICK STEEL PLATE
WELDED STIFFING
3/4" STEEL TUBESHEET BOTH ENDS WELDED TO STEEL SHELL
STEEL HEAD
36" + MINIMUM 36" GIVE THE OPERATOR A CHANCE
AIR OUTLETS
REMOVABLE HEAD THIS END ONLY. TUBES CAN BE DRAWN FROM THIS END
DISHED HEAD WELDED TO SHELL NOT REMOVABLE
CIRCULATING WATER INLET
CLEANOUT
CONDENSATE OUTLETS

General arrangement of a 20,000 sq. ft. two pass condenser of new design developed by G. W. Saathoff prominent public utility engineer long identified with the Cities Service Co. and now a consulting engineer of Electrical Advisers, Inc.

giving access directly into the water box, two each end. Through the manholes men can get in and out; once in they can work with freedom to clean tubes or plug tubes. The only reason for removing the one and only head is to remove or replace tubes and for this the steel head is light and easy to handle, and does not require an act of Congress or a 150 t. crane to get it off.

In the condenser field today we have a group of manufacturers each of which does excellent work and obtains predicted results. All of them will guarantee the same vacuum, condensate depression and deaeration of condensate, yet each has his own proven method of obtaining these results.

Until recently condenser shells were made from heavy cast iron. One progressive concern, a few years ago, had the temerity to build a condenser with a steel shell. While this was a great departure in the public utility field, Heaven knows why, for in the marine field the steel shell was used regularly many, many years ago.

It is believed that construction methods and materials have been backward, that progress has been slow in advancing construction details. The buyers have been entirely too conservative in their demands for improvements and for a reason, why? for each detail.

Discussing the lateness in acceptance and use of steel shells for condensers, one prominent engineer from a buying concern said: "We began to use steel shells when welding became dependable." This was his defense; but did we not build tanks, ships, boilers and pressure vessels by riveting, and, incidentally, many, many marine condensers the same way? (We admit the marine steam condenser was small; the largest one with which we are familiar contains only 9600 tubes.) Does not this indicate a lack of determined buyer-engineer demand for earlier progress? Someone says the shell should be ¾ in. thick, tube sheets a certain thickness, etc., but should they?

Did anyone who needs a condenser for a certain service ever sit down and ask a complete and definite reason for each and every part in design for his job? Don't use a book, or something someone else said or did; don't give as a reason some past construction. But, why should the shell be a certain thickness? Why everything? Get a real answer from real knowledge and, remember, in dealing with a condenser, what insignificant pressures you are dealing with. Remember a torpedo destroyer is of very thin plating and what a pounding it takes. Remember the terribly heavy cast iron shell you bought in the past when thin, riveted shells were better? Remember the 1½ in. thick cast iron support plates you bought and paid for?

These notes, with a determined buyer support, will result in the improvement of materials to which you are entitled and have been for many years—why the lack of progress? Remember when a condenser design was a shell with all the tubes you could get in it, with 2 sq. ft. or more per kw. of turbine it served? Then, like a fog lifting over the Newark Meadows, a new era when Paul Bancel led us out of two or more square feet per kw. and then Weir, of Glasgow, brought out their wide, open steam spaces. I have no desire to advertise them but to recognize their accomplishment. They say that Spanish, French, Portugese and Italian languages are derived from Latin; from what are condenser designs derived since the 2 sq. ft. of condensing surface for 1 kw.?

From a more practical operating and maintenance standpoint there are many important discussions pertaining to packing condenser tubes, features of design that permit practical operating advantages and economies. To a large extent, and an increasingly larger extent, these are not neglected, not forgotten; no they are not even considered.

Analyze all the details of condenser design — packing, stays, tubes, tube sheets, shells, support plates, water boxes, heads, bolts, collar bolts, manholes, gaskets. In all these details surely many improvements are possible.

Recently an engineer was telling about changing the type of tube he was using to one that would solve his troubles. He was asked: "How long did the former tubes last?" He replied, "twenty years," still someone had sold him the idea that another mixture was better.

Perhaps I'm wrong, perhaps I'm right, perhaps someone may disagree; if they do and yet some improvement follows through which all will benefit—fine, the candle will be worth the flame.

Research Activities

DURING 1940 research activities resulted in the completion of nine laboratory projects and the initiation of eight new investigations at the ASHVE Research Laboratory and at cooperative institutions according to the annual report of the society's Committee on Research.

Completed laboratory investigations have dealt with the effect of radiation on the sensation of warmth of an occupant in an enclosed space, and reactions of individuals to environment having low relative humidities. Additional studies have also developed data for establishing heat gain through windows with various types of appurtenances; frictional flow of water in large size pipes; and comparative performance of air filters utilizing various methods of test.

Among the new investigations which have been outlined and initiated are those dealing with noise transmission in ducts; heat losses from basements; air flow in duct transitions; and studies to establish basic design factors in radiant heating and cooling.

DIESEL PUMPING PROVES RELIABLE AND ECONOMICAL

Manhasset-Lakeville Water District reduced its pumping costs 75 per cent by installing Diesel engine in place of electric motor

By OTIS A. SIBLEY

Fig. 1. Superintendent J. B. Reeves recording readings of tachometer on new Diesel pumping engine

WHEN WATER works commissioners can increase the capacity of a pumping station and, at the same time, reduce pumping power costs by almost three-quarters, it is good news for tax payers in their district and important news for citizens of other communities. This is exactly what happened in the Manhasset-Lakeville Water District of Long Island, New York, and carefully kept records are available to prove such economies, as well as greater dependability of supply to the mains for an extra dividend. Fortunately, the answer to this paradox is neither complicated nor expensive, and a full explanation with authentic operating figures should be of interest to all who appreciate the value of a more reliable public water works with substantially less power expense.

Prior to the spring of 1940, this station operated with one motor-driven deep well pumping unit rated at 1100 g. p. m., and with a 14-yr. old, 110-hp. Diesel-driven reciprocating pump, which is now used for stand-by service and light load periods. The large deep well pump is powered with a 200-hp. motor, and electric current was purchased from the local utility. Steadily increasing water consumption of the growing communities served by the station necessitated expansion of pumping facilities last year, and the Commission, consisting of Kenelmn Eden, Chairman; George L. Gehrig and Clarence G. Hamel, undertook an investigatiton of new equipment. To assist them in this survey and to supervise the planning and installation of an additional pumping unit, the Commission retained Sidney B. Bowne as consulting engineer.

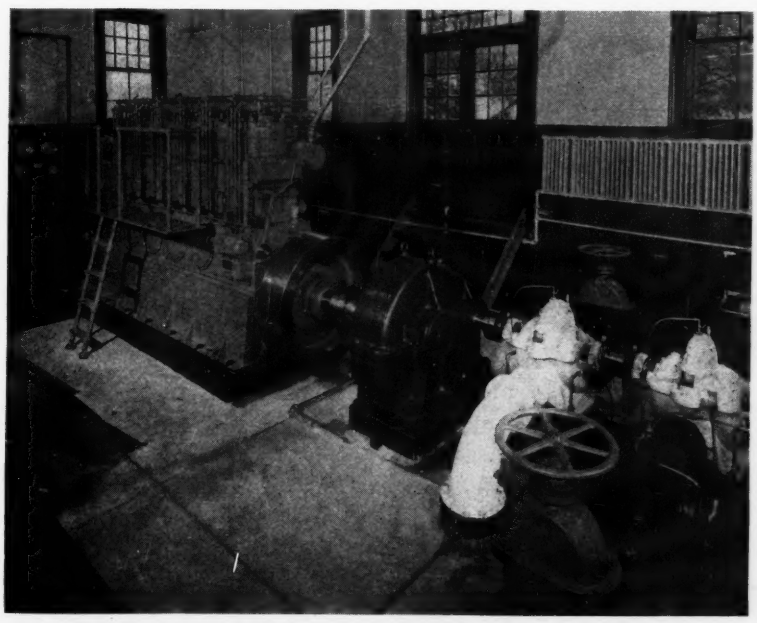


Fig. 2. New Diesel drives two centrifugal pumps through a speed increasing gear

In the light of past experience it is not surprising that considerable attention was given to modern Diesel pumping units, since these are not subject to service interruptions during electrical storms, due to circuit breakers "kicking out", and provide an absolutely independent source of power under all conditions of emergency. This point was well emphasized to the members of the Commission during the hurricane several years ago. In fact, had it not been for the old Diesel unit at that time the entire station would have been paralyzed for six hours until utility power could be restored. The danger from fire under such conditions is obvious.

As it was, no interruption of service occurred and water was supplied to the neighboring district by connecting adjacent fire hydrants with a length of hose. Thus, Diesels thoroughly satisfy the prime requisite of water works service, which is dependability. Operating records indicated substantial savings in power costs as well, so this type of unit was selected.

The new equipment consists of a six-cylinder, heavy-duty type Atlas-Imperial Diesel, rated at 275 hp. at 300 r.p.m. and connected through a flexible coupling and Link-Belt speed-increasing gear to two single stage De Laval centrifugal pumps in series, delivering against a total head of 391 ft.

These pumps have a capacity of 2000 g.p.m. each at 1800 r.p.m.

Practically all engine auxiliaries are integrally mounted except the Alnor pyrometer, a starting air compressor and the Maxim exhaust silencer, located at the rear of the building. Thus engine and pumps form a simple, compact unit that fits easily into space previously occupied by obsolete equipment. Jacket water is cooled by a Condenser Service & Engineering heat exchanger located in the discharge line from the pumps.

To insure nothing but clean air entering the cylinders, two Vortox air cleaners are installed on the intake manifold of the engine. Fuel and lubricating oil lines are fitted with Purolator filters. For positive action and maximum simplicity of engine room layout all elements of the new pumping unit are shaft-driven, and even the vacuum pump is direct-connected to an extension of the second pump shaft. The engine cooling water circulating pump drives directly from an extension of the high-speed gear shaft on the side opposite from the first pump. The Turbine Equipment Co. of New York City acted as general contractor and furnished and installed the Diesel, pumps, gears and auxiliary units. The unusually compact and efficient arrangement is well illustrated by the general view of the new equipment.

Performance of the new Diesel as a pumping engine is best judged from actual data, which are averaged from six trials made under the direction of Superintendent J. B. Reeves:

Suction lift .....18.39 ft.
Discharge head ..161.50 lb.
Total head .....169.20 lb.
Delivery .....2038 g.p.m.
Engine load .....248 b.hp.
Engine speed ...297 r.p.m.
Fuel consumption .....
..0.394 lb. per b.hp. per hr.

Accordingly, it required 110 gal. of fuel to pump 1,000,000 gal. of water at a total cost for both fuel and lubricating oil of only $8.16 allowing for periodical changes in lubricating oil and a maintenance sinking fund at the rate of $1.00 per horsepower per year.

Diesel Cuts Costs Nearly 75 Per Cent

Compared with an electric power cost of $32.20 per million gallons in the same plant and under similar conditions, the saving effected by the Diesel amounts to 74.2 per cent or $24.04 per million gallons pumped. The motor-driven pump carried the full station load from February to May, 1940 while the new Diesel unit was being installed and thus earned the lowest purchased power rate possible, which averaged only 1.54 cents per kilowatt-hour.

Since no additional workmen are required by the Diesel pumping unit, items of overhead can be considered constant and annual savings computed on the basis of power cost saving multiplied by millions of gallons pumped per year. Obviously, the Diesel will soon pay for itself, after which the substantial difference in pumping costs can be applied against further plant expansion and modernization or both, according to future needs.

The Manhasset-Lakeville Water District is typical of many such districts throughout the United States. It covers approximately 16 sq. mi. presenting a variety of service problems. There are 28 wells at the station, ranging in depth from 140 to 150 ft. and one deep well of 428 ft. At the present time, about 4000 regular consumers are served, and the steady growth that has characterized the communities served may be expected to continue.

Rising costs of government and public services can best be met by increased efficiency, both in men and machines, and there is no better place to start than in the local districts where savings are most quickly identified and appreciated. The proven economy and thorough dependability of Diesel-generated power provide the desired opportunity in the form of a self-liquidating investment that pays worth-while dividends in better and less expensive service.

Direct Before and After Comparison

Seldom is it possible to obtain the direct comparison of cost between Diesel power and purchased electric power that this station affords. For that reason the operating figures quoted carry extra significance for all concerned with municipal power responsibilities. After six months of service operation averaging 18 hr. per day at a water pumping capacity of over 1500 g.p.m., the Diesel has exceeded all expectations and the members of the Commission are to be congratulated upon their judgment and alert appreciation of opportunities to improve service at less operating expense.

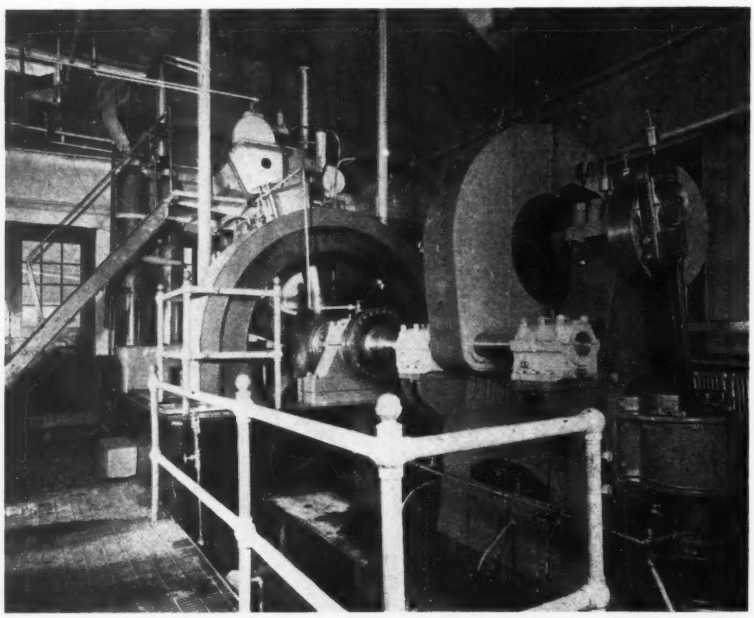


Fig. 3. Diesel driven pumping unit now used as standby after 14 yr. service

SELECTION OF PUMP MATERIALS

Satisfactory life and service of feedwater pumps depend to a large degree upon the care with which the construction materials are chosen in relation to the feedwater treatment system. Corrosion, erosion and scale deposits are factors that need consideration when specifying pump materials

By S. E. TRAY
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Allis-Chalmers Manufacturing Co.

IN SELECTING materials of construction for pumps it is necessary to investigate carefully the type of water which will be handled by the pump. The expected life of pumps is largely dependent upon the chemical characteristics of the water. This applies equally to pumps handling process water, sewage, paper mill waste, condensate, and boiler feedwater. Each application must be considered individually and all of the factors for a particular installation should be carefully evaluated.

Often there are materials which would give excellent service in contact with a corrosive water, but they may not be as suitable for mechanical reasons as other materials which do not have as good corrosion-resistant properties. The expansion of the materials used must be studied to give reliability first of all, and to prevent undue stress in the rotating element and on the pump casing itself. At the same time the metals which readily seize should not be used adjacent to each other where the internal clearances are close. If the pump is to handle suspended solids due consideration must be given to selecting materials which resist abrasion, as well as being suitable for the chemical characteristics of the water.

There are a number of characteristics of water which affect the selection of materials for the pump as well as its performance and service. Foremost among these is the pH value, a term used to designate the relative acidity or alkalinity of a solution. The presence of dissolved gases and their influence on the rate of corrosion of pump materials cannot be neglected. Corrosion is a dissolving of metal and an oxidizing reaction. Factors contributing to corrosion are oxidizing agents and compounds capable of direct action on metals.

pH Value

"pH Value" is a mathematical expression referring to the concentration of hydrogen ions in solution. All solutions contain hydrogen and hydroxyl ions. Those in which the hydrogen ion concentrations exceed the hydroxyl ions are acid solutions; and, conversely, where the hydrogen ions are less than the hydroxyl ions, the solution is alkaline. A neutral solution is one in which the hydrogen and hydroxyl ions are equal in concentration.

For practical purposes the pH scale may be considered similar to a thermometer scale. The pH scale has a range from zero to 14, with a value of 7, the midpoint on the scale, being considered as neutral with respect to acidity and alkalinity. pH values on the scale below 7 indicate acid solutions, the acidity increasing as the pH values approach zero. In the same manner, pH values above 7 represent alkaline solutions which become increasingly alkaline at the upper end of the scale.

Figure 1 is a graphic representation of the pH scale and is analogous to the degree scale on a thermometer. The important difference, however, lies in the fact that since the pH is a logarithmic function, each unit on the pH scale represents a ten-fold increase. For example, a pH value of 9 is ten times as alkaline as a solution with a pH value of 8 and 100 times as alkaline as a solution having a pH value of 7. The same relation applies in the acid range.

Measurement of pH Value

The determination of pH value of water is made either by means of color comparators or by electrical potential methods. The colorimetric method depends on the fact that certain organic indicators impart a definite color to a solution of a given pH value. The color of the unknown solution is compared with a known standard; and, when the proper match in color is obtained, the pH value is read directly.

The electrical potential method measures the difference in potential between two electrodes immersed in solution. A number of instruments of this nature are available on the market and are used where more accuracy is required than is possible by the colorimetric test.

In the measurement of pH values of solutions it is usually necessary to determine this at approximately room temperature. In the case of feedwater or boiler water there are no means at present of determining pH value at the elevated temperatures which are encountered. In the case of water, the hydrogen ion concentration varies with the temperature; hence

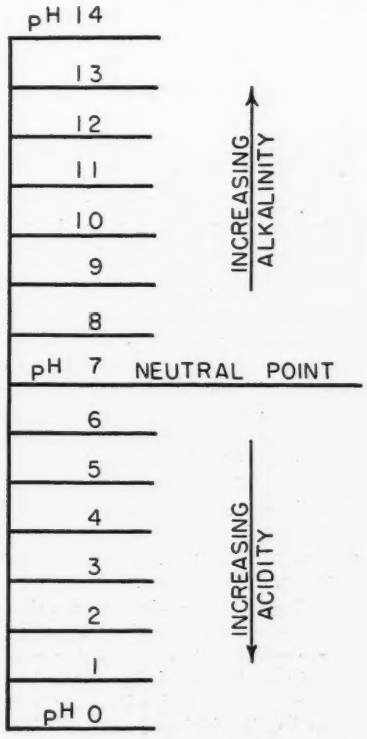


Fig. 1. Graphic pH scale

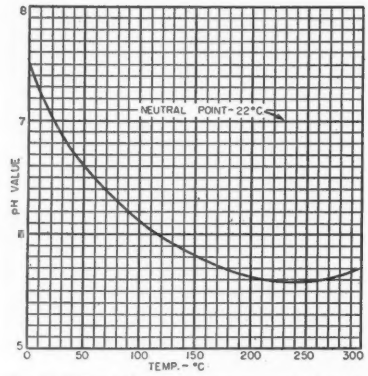


Fig. 2. Effect of temperature on neutral point of pure water

the pH value at elevated temperatures will be appreciably different from that at room temperature. Figure 2 shows the change in the pH value of pure water with temperature. Normally, however, all pH measurements are made on solutions at room temperature, and the results obtained will be entirely comparative.

Application and Range

A knowledge of the pH value of the water which must be handled by pumps is of considerable assistance in selecting the proper materials of construction. This information, together with other chemical analyses of the water, such as hardness and dissolved solids, will indicate the possibility of scale deposits in the pump.

There is no definite pH value which will prevent corrosion on all types of materials used in pump construction. In steam power plants, for example, the pH value of the feedwater in any particular plant will depend largely on the make-up requirements and the treatment specified to make the water suitable for use in the boiler. In central stations where the make-up requirements are relatively low, the make-up is usually supplied as distillate from evaporators. As a result feedwater in central stations is composed largely of condensate, which approaches distilled water in purity. Such a water, however, may be quite corrosive to pump materials, and the prevention of this corrosion is the chief problem encountered in central station practice.

Where the make-up requirements are high, as in industrial power plants, the feedwater will usually contain a higher content of dissolved solids and alkalinity, and the pH value will be in the alkaline range. It is not often possible to change the pH value of the feedwater for the benefit of the pumps alone. In general, therefore, the materials selected for the pump should be such as to provide maximum protection in the pH range in which the pump will normally operate.

Effective Temperature and Recirculation

Pumps used for industrial application on water at temperatures below 100 deg. F. usually experience little difficulty. As the temperature of the water handled by the pump increases, however, difficulties from corrosion and scale deposits become more apparent. This is especially noticeable in boiler feed pumps which handle water containing potential scale-forming salts. Because of the relative importance of boiler feed pumps, as well as the increased temperature of the water which this type of pump is called upon to handle, the influence of water conditions on this equipment is more vital than in any other application.

In many power plants the feedwater before reaching the boiler passes through feed lines, heaters and economizers constructed of steel. The corrosion of iron and steel in contact with water is largely a function of the pH value. The tendency for the corrosion of iron is appreciably less at higher pH values, and in certain instances it has been possible to increase the pH value of the feedwater to offer additional protection to the feed lines and other equipment ahead of the boiler.

In plants operating with relatively low percentages of make-up, this is most readily accomplished by the recirculation of a small percentage of the boiler water to the suction side of the boiler feed pump. With proper boiler water treatment the pH value of the boiler water itself will normally range from 10.5 to 11.0. The introduction of a small amount of this water having a high pH value into the feedwater containing a low percentage of make-up will result in an appreciable increase in the pH value of the mixture. This does not involve the introduction of any additional chemicals to the feedwater cycle, but simply utilizes the normal alkalinity existing in the boiler water as the result of the usual boiler water treatment.

For plants operating with higher make-up requirements the amount of recirculation required is proportionately greater and in many cases may be so high as to be impractical. Under these conditions it is possible to increase the pH value by the constant addition of a small amount of caustic soda to the feedwater. This, however, results in an increase in alkalinities and total solids in the boiler water which may be quite undesirable from the standpoint of boiler operation. It is thus apparent that the entire feedwater cycle must be considered before recommendations may be made to effect a change in the pH value of the feedwater alone.

Dissolved Gases

The presence of dissolved gases in the feedwater exerts a considerable influence on the corrosion of pump materials over and above the effect of the pH value. Dissolved oxygen is most commonly encountered in feedwater and has a marked effect on the rate of corrosion. In general, it may be said that, in the corrosion of iron by water, dissolved oxygen represents the quantity factor while the pH value may be considered as the velocity factor.

In the absence of oxygen, corrosion of iron in contact with water at low pH values proceeds at a relatively slow rate. The presence of small traces of dissolved oxygen greatly accelerates this action. Normally oxygen is partially removed from solution in the feedwater heater, but chemical treatment is usually required to remove the last traces in the feedwater. Dissolved oxygen is unique in that it is one of the few corrosive gases which does not affect the pH value of the feedwater. Conversely, any change in the pH value will have no effect on the amount of dissolved oxygen present.

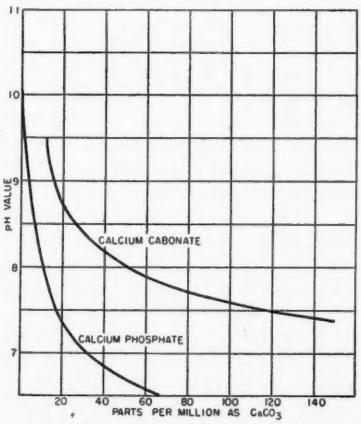


Fig. 3. Effect of pH value on solubility of calcium salts

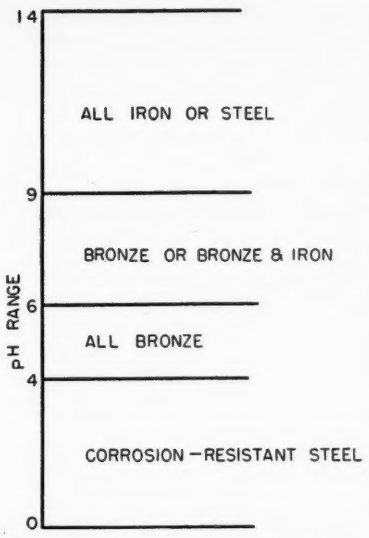


Fig. 4. Materials of construction suitable for handling water with various pH values

Other corrosive gases, such as ammonia, carbon dioxide and hydrogen sulfide, influence the pH value of the water in which they are dissolved. Ammonia, for example, increases the pH value, while hydrogen sulfide and carbon dioxide decrease it. The effect of these gases on the corrosion of pump materials is due to their influence on the pH value of the water as well as the specific action of the gases themselves, particularly on copper and nickel bearing alloys.

Scale Deposits

Waters containing potential scale-forming salts very often form deposits on pump runners and casings, particularly at elevated temperatures. This occurs because most of the scale-forming salts found in water become less soluble as the temperature is increased. The deposition of scale, however, is more influenced by the pH value of water than by the temperature; and, by the proper control of the pH value, it is possible to eliminate completely feed pump deposits. This is especially true where chemical treatment is added to the feedwater for the prevention of scale in the boiler.

Calcium carbonate and calcium phosphate are the most common deposits encountered in boiler feed pumps, and Fig. 3 shows the effect of pH value on the solubility of these salts. It is apparent that at lower pH values there will be less tendency for either of these materials to come out of solution.

In many plants the treatment is designed to maintain a low pH value for the purpose of preventing scale deposits at this point in the cycle. Plants operating with high make-up requirements need considerable chemical treatment and often resort to an acid treatment in the feedwater to assist in maintaining a pH value sufficiently low that deposits will not occur in the pre-boiler equipment. Obviously, however, it is necessary to regulate such treatment carefully since too low a pH value will result in corrosion.

In some cases certain organic materials such as tannins have been employed to delay the precipitation of scale-forming salts in the feed pump and feed lines. These have not proved entirely satisfactory, particularly where feedwater receives additional heat from two or more heaters in the cycle.

Material Recommendations

It will be apparent that there are a number of factors which affect the selection of materials for pumps in a feedwater cycle. The determination of pH value alone is not enough on which to base the selection of materials. On the other hand the pH value of the water may serve as a tentative guide in the selection of suitable materials for pumps if other factors are also given proper consideration.

Each application must be studied for the possibility of electrolytic action if two dissimilar metals are in contact in a strong electrolyte. Likewise, the effect of temperature, the effect of dissolved gases, and the relative cost of the various commercial materials will all exert their influence in the final analysis of the problem.

From the standpoint of pH value alone, Fig. 4 may be referred to for the selection of pump materials. Ordinary carbon steel or cast iron will be satisfactory for alkaline solutions. For neutral or slightly acid water, bronze, or a combination of bronze in the rotor and iron in the casing, may be used. All-bronze pumps resist corrosion in moderately acid water, while strongly acid solutions require the use of special corrosion-resistant steels. To resist internal wear for high temperature, high pressure service, nickel and chromium steels are often recommended.

To select intelligently proper materials for boiler feed pumps, certain information should be supplied the manufacturer relative to the characteristics of the water. This should include the following:

1. Temperature of the water at the pump.
2. pH value.
3. Dissolved oxygen content.
4. Ammonia concentration.
5. Sodium chloride concentration.
6. Sodium sulfate concentration.
7. Hardness and alkalinity.
8. Per cent of make-up.
9. Type of treatment water will receive.

With this information, it is possible to select pump materials which will insure long life and reliability at a minimum cost.

TEXTILE DRYING

DRYING OF TEXTILES is a big subject with literally hundreds of different treatments and processes so it is necessary for the industry to make use of many forms and types of driers. To give an idea of improvement recently made in this field, it is only necessary to point out that whereas not so many years ago it required about 10 min. to dry dyed cotton in an automatic drier, today in the most modern type of raw-stock drier dyed cotton is being dried in 1¼ min., about one-eighth the former time.

Recently, interest has been aroused in the possibilities of drying by means of infrared radiation. Reduced to its simplest form, this merely means drying with radiant heat instead of heated air. For any substantial amount of heat energy to be transferred by such radiation the radiant member must be at a high temperature, such as the filament of an electric-light bulb.

Drying by means of the passage of high-frequency electric current through the material to be dried has not been widely publicized. The high-frequency current with its extremely short wave length has a tremendous penetrating effect.

In both methods of drying by electricity (infrared and high frequency) there are three basic limitations: First, the great concentration of power necessary to evaporate the large amounts of water required in the commercial drier make the first cost of equipment in both cases extremely expensive. Second, the present life of lamps and tubes is only 5000 hr. which means that these items would have to be replaced in 1 to 2½ yr. Third, basic cost of evaporation is approximately five times that by steam.—*Fred Kershaw before the A.S.M.E.*

Do you run a refrigerating plant? Do you aspire to run one? Do you think you would like to run one? Whether you can answer any of these questions in the affirmative doesn't matter, we still think that you will find this story of the Refrigerating Engineer of interest. This is only the first chapter and while there is some excitement in it the chapters to follow are even more exciting. You really will have no idea of the awful mess you can get into in running a refrigerating plant until you read this story by Mr. Holman. Mr. Holman runs a refrigerating plant so his narrative is based on practical experience.

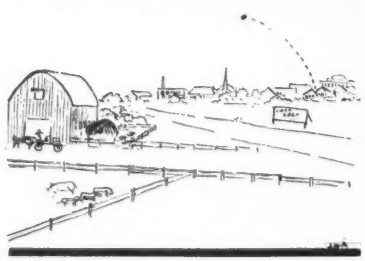
REFRIGERATING ENGINEER

By GEORGE HOLMAN

SO YOU have a notion that you want to be a refrigerating engineer? You think it would just be the berries to have a job as an operator or maintenance man of refrigerating equipment.

You have had this notion in your head for several weeks while doing odd jobs around town but so far nobody has seen fit to help you realize your ambition. There are several ice plants as well as dairies and a cold storage plant in town and you have been around to all of them but with little avail. They can't use you. Your general maintenance and pipe fitting experience, it seems, is no asset when it comes to getting a job in a refrigerating plant.

Still the idea persists and you hate to let go of it. Among your acquaintances there are several men who are operators in refrigerating plants and you have seen enough of the plants in which they work to make you think you would like refrigeration as a field to work in. Refrigerating magazines have come your way but most of the material in them is too technical for you to understand. So, what to do.



A Small Object Rises Skyward

You have been out of a steady job for several months but have managed to keep the wolf from the door by picking up odd jobs around town and on nearby farms.

On the afternoon this narrative begins you are repairing fences on a dairy farm just north of town. A hundred Holsteins are in a board-fenced lot near one of the dairy barns. The regular hands are spraying them to protect them against flies. A breath of wind drifts lazily up from the south.

You are looking toward the barns—and quitting time, figuring on making the job last another day. In town somewhere beyond and behind one of the barns you see a spinning object, small because of the distance, rise skyward. About the time it reaches its extreme height of a hundred feet or so a muffled boom comes through the air from that direction. You see the object, seemingly no bigger than a man's hat, plummet downward and disappear behind the roof of the barn.

You bend a cleat in an angle-iron post and walk back to your wire stretcher. Happening to glance in the direction of town and the barns again, you see people dashing out of the first dozen or so houses and running about every which way. You think there is a fire, maybe, but you can see no smoke.

Your eyes settle on the cows in the lot. You can just see their backs as they mill about behind the board fence. They push the near fence heavily. All at once three sections of the fence go down and cows literally pour over it in a mighty wave. Like a tidal wave and at about the speed of one they cross the pasture. They are within 50 yards of you before you realize that the fence you have been fixing will not stop them.

With something which you can only describe as speedy caution, you gallop along the fence in an effort to get out of the way of the oncoming cows. As you run you look for and find what seems to be a safe opening in the ranks of the racing herd. The opening forms a lane into the dusty trial the cows are leaving behind them. You duck into the opening—and right smack into the thing the cows are running from. Spirits of Hartshorn! Ammonia gas on the loose.

You fall down and roll over. Lying on the ground and with your eyes smarting from the unaccustomed sting of the ammonia, you see the wave of frightened beasts hit the fence you have been work-

ing on and go on through it like a foul ball through a window pane.

As soon as you can keep your eyes open and breathe without discomfort you turn to see what has become of the Holsteins. One cow is lying on a now horizontal section of the fence. Two others are hobbling away. The rest of the herd is straggling about in a field of knee-high corn beyond yet another fence.

Now there is always something about a fire, a picnic, a threatening riot along a picket line or a quack selling snake oil on a corner that draws you toward it like iron toward lodestone. You have hardly ascertained the position of the Holsteins when you find yourself making pretty good time as you travel toward town. You are pretty sure you know where the ammonia is coming from, for you have smelled it at all the places where it is used in town. Your second wind comes up to do its duty by the time you jump the last fence and cross the city limits 200 yards west of the dairy barns.

Inside the city limits you run to join a rapidly increasing crowd in front of the Wholesale Ice Plant and Food Market. You notice that the crowd keeps well to windward of the building, and that the only policeman in sight does not have to tell anyone to keep back.

The city firemen have been speedier than you have. They are already on the job, and are connecting a hose to a nearby hydrant. What they are going to use the water for has you guessing. There is no sign of a fire anywhere. They are not working under the supervision of Firechief Burns, but under the direction of Frosty Coldfax. Frosty owns and operates the biggest of the town's ice plants, situated four blocks away. Earnest is Frosty's real given name. But everybody calls him Frosty, whether from his occupation, his surname, or from his gray hair, gray eyes and gray moustache, you can't say. As you come up the eyes and moustache are disappearing into a gas mask.

"Keep the water just ahead of me! But keep it off the motors!" Frosty lifts his mask to call to the two firemen at the hose nozzle. He lets the mask slip back over his face. With the canister flopping on one hook of the suspender-like harness he wears, Frosty runs along the side street to the machine room door of the plant. The clop, clop, clop of his footsteps brings you to look at his feet. He is wearing shoes with inch-thick wooden soles.

Under Frosty's wood-shod feet a boiling and hissing liquid is trickling out the doorway. A white, steamy vapor rises from the liquid to vanish into the air. As the water sputters then spurts from the nozzle, the firemen direct it against the outer wall, then through the doorway against the open machine room door. The water strikes the door and splashes back to fall upon the

The Firemen Were on the Job

sidewalk. As it mingles with the boiling liquid trickling out the doorway, a series of minor explosions somewhat like firecrackers going off takes place. Against the deep pulsations of the machines still running in the room, the crackling little sounds seem shallow and superficial.

With the water from the hose just clearing his head, and with the incessant popping going on under his feet, you see Frosty disappear into the gas-filled plant. The beat and vibration of the machines begin to die out. Frosty has evidently shut them off. The firemen shift the hose until the water again splashes against the outside wall. Frosty reappears. He is dragging something. You move closer, and discover that the something is a man, either dead or unconscious.

Three or four volunteers from the crowd run up and relieve Frosty of his burden. They carry the limp form across the street to Dowell's lawn. A fireman runs up with a bottle containing a liquid. He dashes some of the contents of the bottle into the prostrate man's face, into his mouth and nose, and pours the remainder on the hands and body. One of the volunteer workers turns the man over and begins to apply the Schaefer method of artificial respiration. You move closer, and discover that the man Frosty has dragged out of the plant is Montgomery La Mar, engineer of the second shift. As you watch the attempt to save Montgomery you pick up the bottle the fireman has emptied on him. You smell the bottle, then taste the few drops of liquid remaining in it. Hmmmm. Vinegar.

You turn back to the machine room doorway. Frosty is dragging out a second victim of the explosion, whom you at once recognize as Terry Letterbee, the regular day engineer. The explosion, then, must have taken place at about the time of the three o'clock change of shifts.

A second group of volunteer workers take charge of Terry, and for the third time Frosty disappears into the plant. Montgomery is now breathing. But the second crew does not have time to try to resuscitate Terry. An ambulance has stopped in front of the Food Market, and both Montgomery and Terry are loaded into it.

Dripping wet, Frosty reappears at the machine room doorway. He waves and the ambulance speeds away.

Frosty looks back, then comes on out and takes off his mask. His wet clothing reeks of ammonia. "Better keep the water on it for a while yet," he tells the two firemen, who have carried the hose nozzle closer to the doorway. "I've got everything shut off. But the valves don't hold well. The sewer drains are the highest places on the floor. And when I went in the low places were pools of anhydrous. Now they're full of strong liquor. The motors might be damaged by the water; so miss them if you can. I've already pulled the main switch. Nobody will get electrocuted."

"What happened?" you ask Frosty, trying to visualize "pools of anhydrous."

Frosty holds out a gnarled hand until his fingertips touch the cutting stream of water from the hose nozzle. From his hand water splashes lavishly over his already soaked clothing. "The liquor in my duds is a little too strong; it's biting," he explains his action to the two men at the hose nozzle. "I've got to weaken it a little. Whenever you run across free ammonia anywhere, just think of water as a safety precaution, and you can't go wrong. It puts out ammonia just like it puts out a fire. That water falling through the air in there has taken up most of the gas already."

So that is the why and the wherefore of the water. Frosty turns to you. "A head blew off a compressor," he answers the question you are about to repeat. "It went right through the roof, and quite a ways up. It came down

through Finley's roof nextdoor. A 60 lb. head. Stripped the threads on six studs and took two of them through the roof with it."

The firechief has come up. "If a compressor blew up, where did that liquid ammonia on the floor come from?" he asks Frosty, and edges over to peer into the gas-filled room. "I thought when I saw it that a liquid receiver had blowed up or a liquid line had gone bust. I worked in a ice plant one time, but I didn't learn a whole lot about it."

"The liquid came from the brine tank coils," Frosty says. "If a receiver had blown up, the head pressure would have fallen to zero. But when I was in there the gages still showed 165 lb."

"When the head went off the compressor, the pressure in the tank coils fell," Frosty explains. "The liquid just naturally boiled over and out through the suction trap valves of the compressor to the atmosphere. There was a safety head on the cylinder that blew. But when the liquid started to come through, it was knocked clear out of the machine. The compressor was still running when I got there, and trying to pump a vacuum in the coils. But with the float regulator opening and closing as the liquid surged up and down, more liquid kept feeding in from the receiver. The compressor kept trying to empty the coils, both of liquid and of gas. And judging from the level of the liquid in the receiver, it pretty near done it, too."

Which might be understood by a refrigerating engineer, but which is far from being clear to you. "Why should the compressor blow up?" you ask.

"We won't know exactly until either Terry or Montgomery comes to and tells us," Frosty replies. "The discharge stop valve of the compressor was closed. But whether the compressor had been started with the valve closed, or whether the valve had been closed after starting, I couldn't tell."

Valves! Here is something right down your alley. "The discharge stop valve. That's the most important valve on a compressor, isn't it?" you ask.

"It may not be any more important than the suction stop valve or the suction and discharge trap valves," Frosty explains, "but it is a sight more dangerous. It is something that every plant operator ought to think twice about before he starts up a compressor. All three compressors are wired to operate either by automatic or by manual control. The buttons on all three of them were set for automatic operation. It may be that Terry or Montgomery closed the discharge valve for some reason, then forgot to open it before setting the button in starting position. In that case a rise in the brine temperature would have started the compressor by thermostatic control. Or maybe they forgot that the button was set automatic."

"How much ammonia got away, do you think, Frosty?" the firechief asked.

"Two or three thousand pounds," Frosty says nonchalantly.

"Two or three thousand pounds?" you repeat. "Is that all? There must have been more than that. Why, it was so strong in the air a quarter mile the other side of Goodpasture's Dairy that I could hardly stand it. There was so much that Goodpasture's cows took out across the country like runaway racehorses."

"You must have been in a direct line with the wind from here," Frosty says. "But a little bit of this ammonia goes a long way. A mighty long way. A ton of it would easily be noticeable in a billion cubic feet of air. And a quarter of a percent of it in air is dangerous to breathe for any length of time."

Lawsuits

At that minute you remember your wire stretcher. It is now past quitting time, so you go back to the dairy merely to gather up your tools. About the barns you find that the odor of ammonia has disappeared from the air. The dairy hands have gone out to round up the cows. The cow you saw lying on the fence is dead of a broken neck. The two you saw hobbling away have broken legs, and are to be shot. A dozen others have been cut and scratched by the fences they have gone through.

Goodpasture is raving. "So the Wholesome plant blew up, eh?" he fumes. "Well, I'll file suit against them tomorrow. I want you for a witness. A thousand dollars at least they've damaged my herd."

Next evening on your way home you walk past the Wholesome plant. Beginning at the machine room doorway and stretching northward in an ever widening wedge every green plant has been killed by the escaping ammonia gas of the day before. The grass on Finley's lawn, the vegetables in Wilson's garden, the roses around Starr's porch, and even the leaves of the trees along the street are limp and withered in death.

But that is not all. Terry Letterbee has died of his burns. Montgomery La Mar will recover, the doctors say, but has suffered permanent injury to his lungs. Mrs. Alexia Starr has been asphyxiated. She, too, is in the hospital undergoing treatment. Her husband is worried about her condition. Like Goodpasture, he, too, will file suit against the Wholesome plant.

And all because the discharge stop valve of a compressor pumping a dangerous caustic refrigerant under high pressure was closed when it should have been open.

(To be continued)

SOLVING PIPE PROBLEMS WITH MODELS

WITH THE GENERAL adoption of higher pressures and temperatures in central steam plant designs within the last few years came the need for more accurate and reliable methods of solving problems involving stresses and reactions caused by temperature expansions.

A mechanical method was developed to facilitate the solution of such problems by the use of models. Early experiments indicated that reliable results could be obtained by employing small, solid, die-drawn steel rods on the order of ¼ in. in diam. They were found to possess advantages in being easy to handle and form to shape and in yielding readily measurable deflections with the application of small loadings.

Another advantage was the possible exaggeration of deflections to the extent that one might easily observe the effect of various changes in, or the relative importance of, the applied loadings. In this respect the testing device may be thought of as an analyzer.

Consideration was given to the use of tubing with its theoretical advantage of closer simulation, but the practical advantages of rods were decided to be of greater importance. The method is not thought to possess time-saving advantages over mathematic methods for simple pipe runs in one plane having no more than two or possibly three 90-deg. bends when only the end reactions are sought.—*Fred M. Hill before the A. S. M. E.*

CONSUMPTION OF SALT CUT ONE THIRD

Zeolite water softening system cycle altered to include brine recovery tank

By C. C. HARRINGTON

IN THE wool scouring and carbonizing plant of Eavenson and Levering Co., in Camden, New Jersey, over 400,000 gal. of water are used daily. Of this amount, about 53,000 gal. are used as make-up for the boiler. The remainder is used in process work, generally at temperatures over 150 deg. F.

Water is obtained from two wells and varies in hardness from 6 to 9 grains per gallon. In order to make this water suitable for use in the plant and in the boilers, it is first passed through a zeolite softener. The softener is in the form of four steel tanks, each with a capacity of 75,000 gal. between periods of regeneration. They may be used in parallel or individually, as desired.

With the original set-up, this system used 12 bags of salt daily to regenerate the zeolite in the four tanks. This meant that 2400 lb. of salt were used each day; the solution draining into the sewer after passing through the softening tanks. W. A. Lofft, maintenance engineer of the concern, had tests made on this waste solution. These showed that the solution still retained a salt concentration of from 2 to 3 deg. Baumé. Measured in daily lots, this represented a considerable waste of good salt.

The remedy was to install a brine reclaiming system, so as more thoroughly to utilize the salt in the regenerating cycle. The reclaiming addition consisted essentially of a wooden tank with approximately the same inside capacity as one softening tank, a small pump, a few valves and several lengths of pipe. The saving in salt resulting from the new set-up was immediately apparent. Instead of 12 bags being used daily, the consumption dropped to 8 bags; a saving of 800 lb. of salt each day.

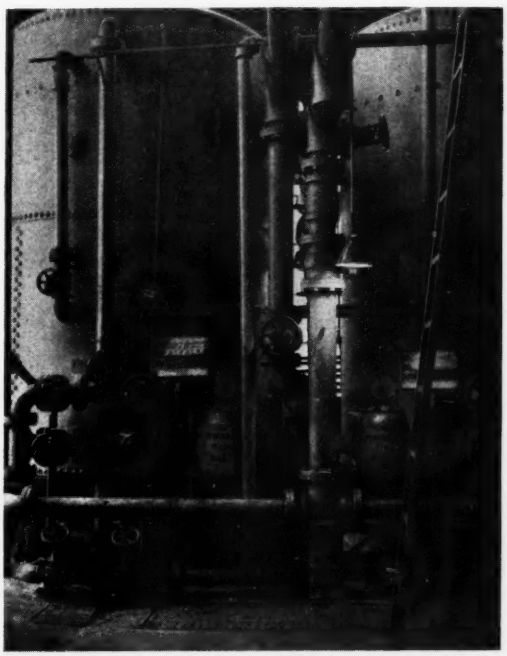


Fig. 1. Two of four softening tanks in Eavenson & Levering Co. plant. Note valve convenience

With the reclaiming system, the regenerating cycle used starts as with the original set-up; namely, allowing a backwash of fresh well water to flow upwards through the zeolite bed at the rate of 200 gal. per min. This loosens up the bed and thoroughly cleanses the materials. The backwash lasts approximately 10 min., until all traces of dirt and soft water has been removed. Then, instead of allowing fresh brine to flow into the tank as was previously done, the solution from the recovery tank is directed through the softener. This weak brine solution, which has been used previously in one regeneration cycle, is the first to act on the zeolite. As this flows into the softening tank, a valve is opened so that the water already in the tank discharges into the sewer, and is replaced by the weak brine.

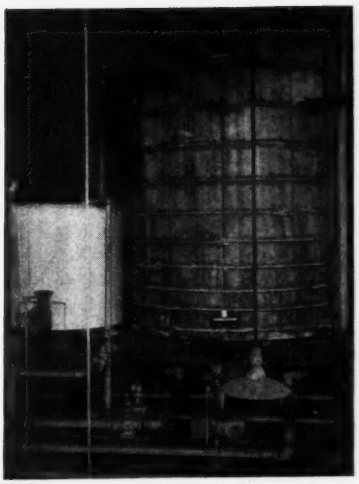


Fig. 2. Mounted above the level of the softening tanks are the measuring tank containing strong brine, shown at the left, and the wooden brine recovery tank

Strong Brine

When the recovery tank is empty, a float switch operates a valve in the discharge line of the small measuring tank filled with strong brine at 10 deg. Baumé. Accordingly, this concentrated solution flows into the softening tank while the replaced weak solution, now completely free of salt, is discharged down the drain. As soon, however, as a saline solution starts discharging through the drain, which means that the concentrated brine is beginning to work clear through the softener, the drain is closed and the solution pumped up to refill the recovery tank. When the measuring tank is empty, a float switch closes the discharge and opens an inlet line which permits the measuring tank to be refilled with concentrated brine from a mixing tank. In the meantime, the brine solution flowing from the softening tank continues to fill the recovery tank. The strength of the solution has been reduced by regeneration and dilution from 10 deg. to 3 or 4 deg. Baumé. Thus, at the end of the cycle, both the recovery tank and the measuring tank are filled and ready for use in another softening tank. The regenerated tank, of course, is completely rinsed with

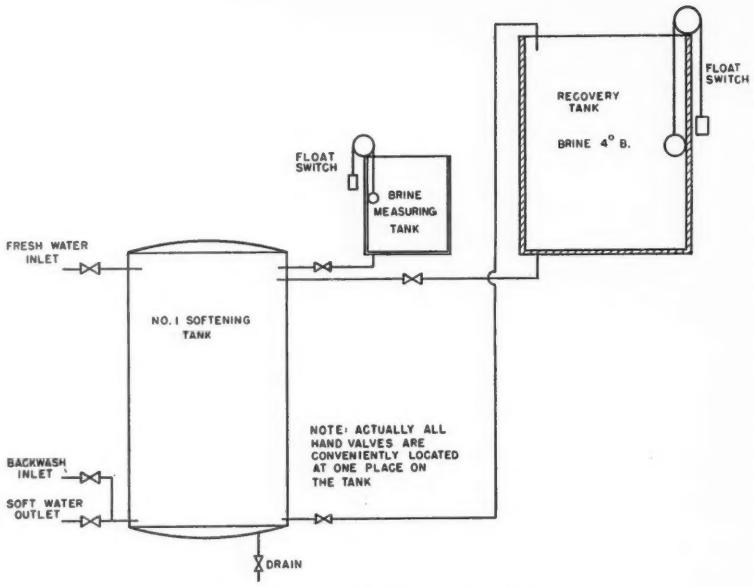


Fig. 3. Diagram of brine recovery system

fresh water until no salt appears in the discharge to the drain.

The entire regenerating operation, including the use of the recovered solution, seldom takes more than 45 min. After regeneration, the tank is available until about 75,000 gal. have flowed through the outlet meter; or until a period when three drops of standard soap solution fail to produce a good lather with 40 c.c. of treated water.

ELECTRIC COUPLINGS

Electric couplings have recently been applied on a large scale in geared Diesel ship drives. The success of these installations makes it evident that this device may have application in other fields, the power plant field for example. In this article which is an abstract of a paper presented before the A.I.E.E. the authors outline the principles of the various types of couplings and suggest some applications

By M. R. Lory, L. A. Kilgore and R. A. Baudry
All of the Westinghouse Electric & Mfg. Co.

ELECTRIC COUPLINGS are devices for transmitting torque by means of electromagnetic forces in which there is no mechanical contact between the driving and driven members. Thus, they differ from electromagnetic clutches which are only friction clutches in which an electromagnet is used to apply the pressure between the friction surfaces. Electric couplings are not new in principle, but their application on a large scale has come only in the last few years. It is the purpose of this paper to review the principles of operation of electric couplings, describe their major application to geared Diesel engine ship propulsion, and discuss the engineering problems associated with this application.

Probably the idea of an electric coupling is nearly as old as the idea of an a.c. generator. There are a number of early United States patents from 1891 to 1906 describing at least the elements of the various types of electric couplings. The greatest application of electric couplings has been in the marine field.

The electric slip coupling is the type used on all of the large marine applications. The slip type has poles excited by direct current on one rotating member, and an armature winding, usually of the squirrel cage type, on the other rotating member. If it is necessary to vary the speed, the winding can be insulated and brought out to slip rings, so that an external resistance can be connected in the circuit to vary the slip. Any relative motion or slip between the two members will induce currents in the armature winding which react with the flux to produce a torque tending to hold the two members close together in speed. This is similar in action to the usual induction motor, except that the rotating field is produced by a direct current in a rotating member instead of by polyphase currents in a stator. This type is usually referred to as a wound rotor coupling. The problem of controlling the speed through the external resistance is exactly the same as for the wound rotor motor, except that it is possible to get fine speed adjustments between resistance points by controlling the field current. The efficiency comes down nearly proportional to the slip. This type may find application to Diesel engine drives where it is desired to run below the lowest operating speed of the engine.

A variable speed coupling for certain types of load may also be obtained by designing a squirrel cage slip coupling for high slip and controlling the torque by control of the excitation. This is analogous to controlling the voltage on a squirrel cage motor. There are two difficulties in this: The high slip necessary for any appreciable range of slip by field control results in lower efficiency at full speed as well as at reduced speed. The other difficulty is the dissipation of the heat from the armature member, since all the slip losses go into this member.

Instead of a conventional squirrel cage winding, it is obviously possible to use only a solid steel rotor on the armature, making use of the eddy currents induced in its surface. This type gives less pull-out torque and higher slip for the same air gap surface and weight. However, for variable speed by field control, it has the advantage that it can be arranged more readily to dissipate the high slip losses, especially in smaller sizes.

The inductor alternator principle may be used to make an inductor type electric coupling. The field is wound peripherally on one member, dividing the air gap into two sections. The flux is uni-directional in each section and is caused to alternate in the armature winding by the relative motion of inductor teeth on the other member. For a given air gap and pull-out torque, more air gap surface is required in the inductor type machine since the useful alternating flux density is limited by saturation to about half of the value of a salient pole type, due to the superposition of d-c and a-c components of flux. However, where the air gap can be kept very small, this type may result in somewhat cheaper construction for small couplings.

A synchronous coupling can be built by using salient poles and d-c excitation on both members. For most applications this type is less desirable than the slip coupling for several reasons. The increased excitation requirements partially offset the elimination of slip losses, and slip rings are required on both members. The synchronous "spring" torque tends to be higher than in the slip coupling, and if this type of coupling should pull out of step with fields excited, high values of slip frequency alternating torque would be developed which might excite the torsional natural frequency of the connected mechanical system. Also the presence of field windings on both members makes it difficult to obtain high average torques at high slip.

Other Applications

The application of the slip type of coupling to geared Diesel ship propulsion drives is the largest application of couplings made so far. However, it is interesting to note some of the other possible uses for couplings. This same type of coupling can be applied to any Diesel or gas engine where it is desired to limit the engine torque impulses transmitted to the load. It may also be used for the purpose of limiting the maximum torque and avoiding stalling of the engine. In such applications, the pull-out torque of the coupling must be made less than the stalling torque of the engine. It can be used as a disconnecting clutch to shift gears on an engine which is too large for a friction clutch.

The variable speed coupling of either the wound rotor or high slip squirrel cage type may be used with a synchronous motor or a constant speed induction motor to obtain smooth speed or torque control. By use of field control, the speed can be controlled in finer steps than is practicable with a resistance in the secondary of a wound rotor induction motor. As previously stated, the reduced speed is always accompanied by a reduction in efficiency, but this may not be too serious a handicap for a limited range in speed, for short time operation at low speed, or for fan or pump drives where the power varies as the cube of the speed.

For a limited range of speed, or for a fan type of load, it is possible in the smaller ratings to obtain speed control entirely with field control of the coupling, using a slip type of coupling with high resistance squirrel cage, or a solid steel armature.

The electric coupling has filled a definite need in the application of higher speed Diesel engines to geared ship propulsion. The engineering problems encountered in this application have been satisfactorily solved, as proven by the installations which are now in successful service. As time goes on, a larger proportion of Diesel ship drives are being geared, and the percentage of these geared drives on which electric couplings are applied is increasing rapidly.

Now that the electric coupling has been developed and applied on a commercial scale, it is quite sure to find other applications where its characteristics can be used to advantage.

A NEW STEAM ENGINE

A 90 hp., high-pressure, high-speed compound engine and a new type of forced-circulation boiler, with an impeller placed logitudinally in the lower drum described before the A.S.M.E. Test results non-condensing show a water rate of 14.6 lb. with 595 lb., 750 deg. F. steam. Total engine weight 450 lb.

By S. L. G. Knox[1] and J. I. Yellott[1]

CURRENT INTEREST in high-pressure prime movers and forced-circulation steam generators gives timeliness to the following brief description of a compact steam plant which embodies both features. It utilizes a high-speed compound uniflow engine, for which highly superheated steam is supplied at pressures up to 700 psi by a unique forced-circulation boiler. The engine is of the steam-reverse type, that is, the direction of rotation is reversed by changing the direction of flow of the steam by using one set of ports in the valves as steam-admission ports in one direction and as exhaust valves in the other direction. It is designed to operate at 1000 r.p.m. taking steam at 700 psi 750 deg. F. and exhausting either to atmosphere or to a condenser.

In brief, the engine is double-expanding, with one high-pressure and two low-pressure cylinders. The inlet valves are of the piston type, with unique variations. These valves are actuated by an auxiliary crankshaft, which is driven by gears from the main crankshaft. Exhaust from all cylinders is accomplished by uniflow ports, with auxiliary exhaust provided by the piston valves.

Outstanding is the valve gear, by which a number of useful functions are performed without introducing more moving parts than the minimum number required for a simple nonreversing engine with the same number of cylinders. Most important of these functions

[1]Mr. Knox, a consulting engineer of Englewood, N. J., designed the equipment described and Professor Yellott, of the Illinois Institute of Technology of Chicago, conducted the tests.

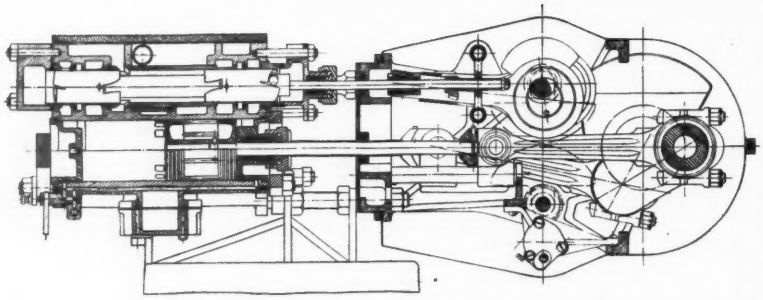


Fig . Cr . section of the engine. Note the irregular contour of the valves, one of the important features of the Knox engine

are the provision of expansion and the automatic increase of torque at starting and low speeds, without additional mechanism. The result of the special features of the engine is a steam consumption of 14.6 lb. per b.hp.-hr. (noncondensing at 1020 r.p.m.), and an engine efficiency of 53.3 per cent, obtained under test when the engine was loaded to about 75 per cent of its capacity.

General construction is shown in Fig. 1, which gives the principal details of construction of the engine, but omits the steam passages. The single high-pressure cylinder, 3¼x4½ in., is located between the two low-pressure cylinders, 4½x4½ in. Steam is introduced through a control valve which serves both as a throttle and as a steam-distributing valve. The direction of rotation of the engine is changed from forward to reverse simply by pushing the control lever to its forward or reverse position.

When running forward, the steam passes from the control valve, to the inner edges of the high-pressure piston valve. These differ from the usual piston valves in two important respects: First, the valve has a rolling motion as well as a reciprocating motion; thus the path of any point on the valve is an ellipse. The second unique feature is the serrated edges.

Each valve is connected to two cylinders; the outer edges to one cylinder, the inner edges to another. If the direction of rotation of the engine is such that the outer edges of a valve admit steam to a cylinder, the inner edges of the same valve will open during the exhaust stroke of the other cylinder, thus providing auxiliary exhaust for the second cylinder without any additional parts being required.

Usefulness of the serrated edges in combination with the unusual rolling motion lies in the fact that the effective cutoff can be lengthened, thus increasing the torque of the engine. The rolling motion of the valve is imparted by a simple arrangement which combines a segmental bevel pinion on the valve stem with a segment of bevel gear on the eccentric strap.

A small slot or notch running longitudinally of the valve makes it possible to lengthen the cutoff beyond that which would be possible with only the reciprocating motion of the valve. When the engine is starting or running at low speed, it is supplied with steam at approximately full pressure during practically the entire stroke. As it speeds up, the amount of steam which gets through per stroke becomes less important. At maximum speed the effect on efficiency is negligible. Thus, it is possible to obtain the effect of a long cutoff, and the resulting increased torque at starting and low speeds, with a fixed economic eccentric position.

Limitation on the output of the engine of 69 b.hp. during test was imposed by the boiler which at the time of the engine tests was unable to deliver more than 1000 lb. of steam per hr. with smokeless combustion. Later the combustion was improved until the boiler developed more than 1500 lb. per hr. without smoke. The furnace volume is 5.67 cu. ft. and heat releases as high as 400,000 B.t.u. per cu. ft. can be obtained with smokeless combustion.

It is reasonable to assume that, with large engines, running condensing, steam consumption much below the 14.6 lb. per b.hp.-hr. obtained with the present engine should be realized. If, as may reasonably be expected, a water rate of 10 lb. or better per b.hp.-hr. should be attained, the fuel consumed per hp.-hr., while considerably greater than that of a Diesel engine, would cost less because of the much lower price per gallon of fuel usable in the furnace of a boiler, as compared with that required in a Diesel.

The Boiler

This boiler, which was developed to supply steam to the Knox engine, had to be compact, and relatively light. The necessity for forced circulation was immediately realized, but the difficulty of controlling the once-through or coil boiler made it desirable to retain the stability and reliability of the conventional multitubular drum boiler. These requirements were met by using a new method of forced circulation, whereby a simple impeller in the middle lower drum, Fig. 2, causes the

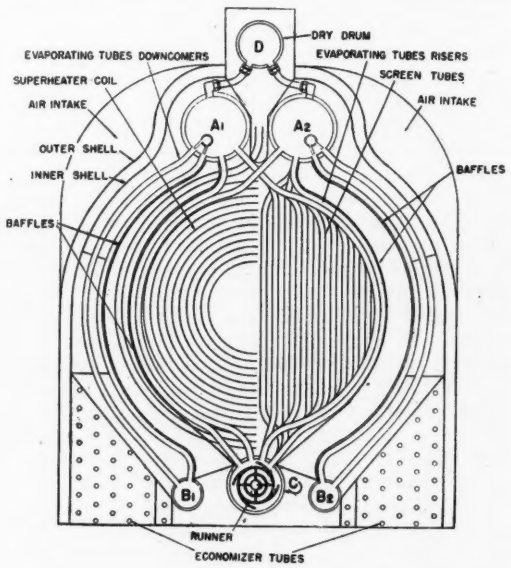


Fig. 2. Cross section of the boiler which is fired horizontally from the front. At the rear the gases reverse, flow over the superheater, forward through an idle pass, then reverse again to pass over the economizer surface. A forced draft fan discharges through a space between the boiler and the outside casing

water to flow up through the riser tubes which surround the combustion chamber.

Risers, through which the water is forced upward to the drum by the impeller, consist of four rows of stainless-steel tubes, ½-in. O. D. and approximately 3 ft. long. The combustion space is entirely waterwalled, although it was found necessary to put refractory over the first few rows of tubes near the burner to provide radiant heat for vaporizing oil to obtain smokeless combustion and improved efficiency.

The superheater is composed of a spiral coil of tubing and is located at the back of the combustion space, facing the burner, but separated from the combustion space by a screen of riser tubes. Control of the temperature of the superheated steam is accomplished by injecting feedwater into the inlet of the superheater. Three economizers are used.

Air Supply

Since the Knox boiler is intended to operate without a stack to produce a natural draft, it is provided with a unique forced-draft system. The entire boiler is covered with an airtight metal casing, which is in turn partly enclosed within a removable aluminum outer jacket. Between this outer shell and the jacket on either side of the boiler is a space through which the incoming air is drawn by the forced-draft fan.

The air, which is drawn in through the fan after having passed over the outer shell of the boiler, is then forced through the space between the inner and outer shells, and is preheated to about 350 deg. F. before it enters the combustion chamber. The air pressure at the burner inlet is about 2 in. of water, under the usual operating conditions.

After passing through the coiled superheater at the rear of the combustion chamber, the gases divide and turn back through the second pass, back through the third pass, then move down into the economizer space, and come to the front of the boiler, where they enter the duct which leads to the last economizer and finally to the stack.

TWIN FURNACE BOILERS

By John Blizard[1] and A. C. Foster[1]

AS THE SIZE of a furnace increases, the ratio of the area of the walls of the furnace to the volume of the furnace decreases. In fact for precisely geometrically similar furnaces, cooled by steam or water-walls, doubling the linear dimensions of the furnace halves the ratio of the cooling surface to the volume of the furnace. Furnaces, however, are designed to give approximately the same rate of liberation of heat per unit volume regardless of the size of the furnace and, consequently, the gases will leave the large furnace at a higher temperature than they will leave the small furnace under these conditions.

With many fuels, this offers no difficulties but for others it means that the gas and the ash, which accompany the gas, will enter the convection heating surface of the boiler and superheater at so high a temperature that ash will be deposited on the boiler and the superheater tubes. This restricts the flow of gas, changes the superheat, and, to some extent, reduces the efficiency of the unit.

In order to obviate these difficulties the fuel may be burned in two or more furnaces, whereby the ratio of cooling surface to total furnace volume is increased and the temperature of the gas leaving the furnaces may be reduced to a temperature low enough to prevent the deposition of molten ash on the convection heating surface. The furnaces themselves may be cooled by waterwalls or radiant superheater surface. The waterwall and superheater tubes should be bare, in order to cool the gases to the greatest extent and as early in their passage from the burner as possible, since this not only reduces the likelihood of slag depositing on the walls but also, by decreasing the mean temperature in the furnace, increases the time taken by a particle of coal to pass through the furnace, thus giving it more time in which to burn.

The use of two furnaces instead of one presents: (a) An opportunity to install a superheater in one or more of the walls of one of the furnaces where, by regulating the relative rates of combustion final temperature of the steam may be held constant or varied as required over a wide-range load; (b) less time is required in starting than where only one furnace, in which there is a superheater, is employed. This is accomplished by firing a small amount or no fuel in the superheater furnace until steam generated by fuel fired in the watercooled furnace passes through the superheater.

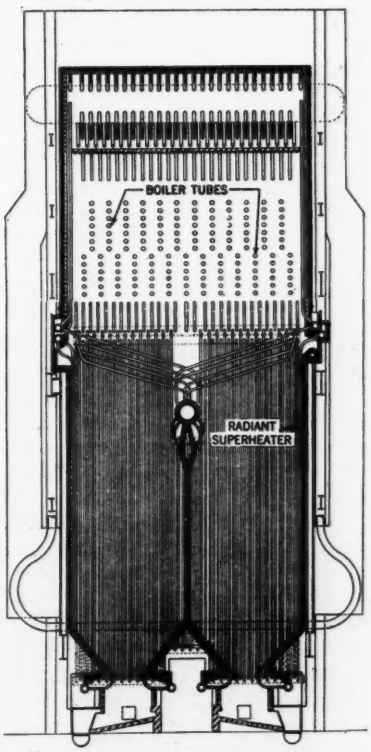


Fig. 1. Section of the two furnace boiler installed at Windsor Station

[1]The authors are respectively: Consulting Engineer and Manager of the Service Department of the Foster Wheeler Corp. This article is part of a paper presented at a recent meeting of the A.S.M.E. For additional data on Windsor Station in which the above boiler is installed see Power Plant Engineering, Modern Utility Stations by Philip Sporn, p. 304 May 1938. A two furnace boiler of somewhat different design is also installed at the Oil City (Pa.) plant of the Keystone P. S. Co. and further details can be found in the article, Modern Utility Stations by James A. Powell, p. 442 July 1938.

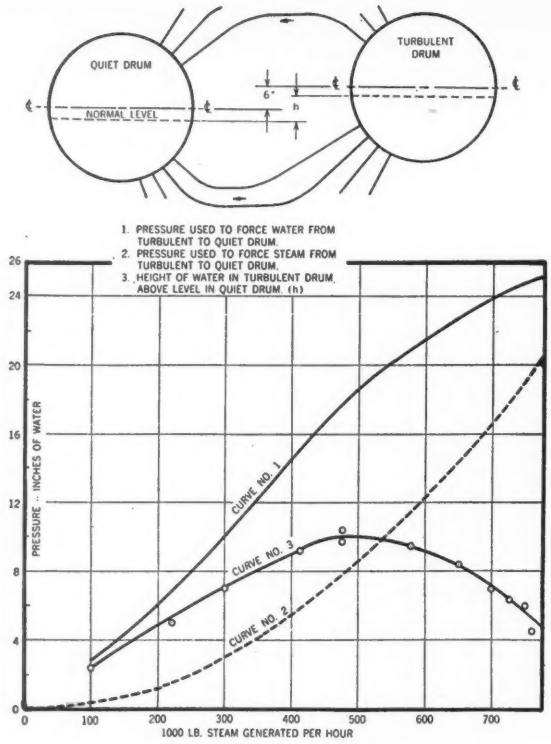

QUIET DRUM
TURBULENT DRUM
NORMAL LEVEL
6"
h
1. PRESSURE USED TO FORCE WATER FROM TURBULENT TO QUIET DRUM.
2. PRESSURE USED TO FORCE STEAM FROM TURBULENT TO QUIET DRUM.
3. HEIGHT OF WATER IN TURBULENT DRUM ABOVE LEVEL IN QUIET DRUM. (h)
PRESSURE - INCHES OF WATER
CURVE NO. 1
CURVE NO. 3
CURVE NO. 2
1000 LB. STEAM GENERATED PER HOUR

Fig. 2. Difference in water level between the water levels in the quiet and turbulent drums

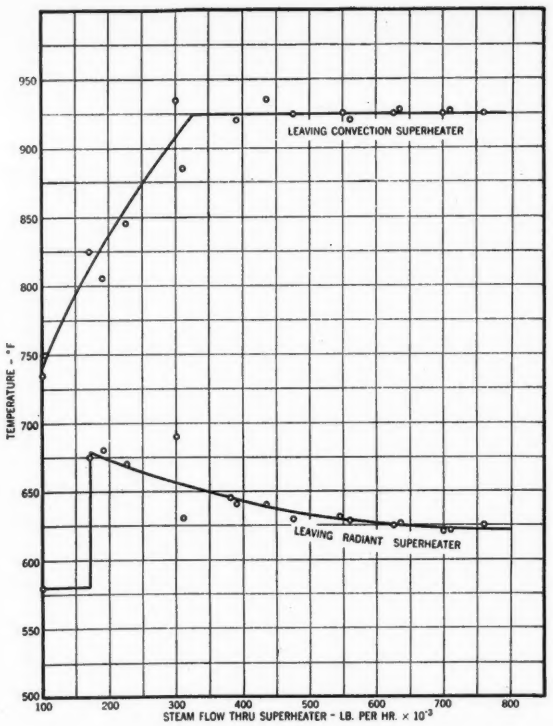


Fig. 3. Final steam temperature is held constant by regulating the relative firing in the two furnaces

In some designs it has been found desirable to place the entire amount of superheating surface in one of the furnaces, while in others it has been found more desirable to place only a part of the superheating surface in the furnace and to superheat the steam further by means of a conventional convection superheater. This general principle of design has been adopted for several boilers now in use, one of which is in operation at the plant of the Ohio Power Co. at Power, West Va. This boiler has been in operation for more than a year and has proved its ability to deliver steam at a constant temperature over a load range of 325,000 to 800,000 lb. of steam per hr., with no undue difficulties from deposition of slag on the heat-absorbing surface.

One cross section of this boiler shown in Fig. 1, the left-hand furnace is cooled entirely by waterwalls, while the right-hand furnace is cooled by water on all walls except the right-hand wall in which is a radiant superheater. The division wall between the two furnaces consists of two rows of tangent tubes, which effectively screen one furnace from the radiation of the other and substantially prevent any material passage of gas between the two furnaces.

The mixture of water and steam leaving the division-wall tubes enters the small drum at the top of the division wall and is conveyed through four rows of staggered tubes, spaced 28 in. horizontally and 14 in. vertically, to the side walls of each furnace. These widely spaced tubes form a slag screen through which the gases pass to an intervening chamber before entering the nest of boiler tubes.

On leaving the boiler heating surface the gases pass over the convection superheater which consists of 2-in. tubes on 3½ in. centers, then to an extended-surface economizer and two regenerative air heaters. The boiler is fired by coal which is pulverized in three ball mills, each having a capacity of 14½ t. per hr.

Two steam drums are provided. All the risers of the boiler and waterwalls enter one drum, called the turbulent drum. Some of the water and all of the steam then pass to a second drum in which a steam washer and drier are installed. From this drum, the steam passes first to the radiant superheater and thence to the convection superheater.

To maintain a uniform level of water throughout the length of the drums, the water leaves the drums through a series of connections spaced along the length of the drums, which eliminates longitudinal flow of water along the drums. Before leaving the turbulent drum, the water passes over a weir, which facilitates the removal of steam from the water before it enters the downcomers. The downcomers are not heated. The levels of the water in the gage glasses on the turbulent and quiet drums are shown near the bottom of Fig. 2, and it will be seen that, when the load rises, the level in the turbulent drum rises above that in the quiet drum.

A further set of readings of the difference between the levels in the steam drums was taken during normal operation of the boiler. These readings are shown graphically by Curve 3 in Fig. 2. Curve 2 shows the pressure required to force the steam from the turbulent to the quiet drum. Curve 1 is constructed by adding the ordinates of Curve 2 to those of Curve 3 and represents the pres-

sure required to force water from the turbulent drum to the quiet drum. It will be seen that the circulation of water increased as the load increased.

Figure 3 shows how the temperature of the final steam varies with the rate of steaming. It will be seen that the final temperature remains practically constant at 925 deg. F. over a range of from about 750,000 to 325,000 lb. of steam per hr. On the same chart is shown the temperature at which the steam leaves the radiant superheater and it will be observed that, as the rating decreases, this latter temperature increases which is brought about partly by this being an inherent characteristic of radiant superheaters and partly by firing at a somewhat greater rate in the superheater furnace than in the saturated furnace at the lower loads.

Had there been no radiant superheater and, if it were felt desirable to keep the temperature at which the gas enters the convection superheater down to about 1850 deg. F. at full rating, it would have been necessary to increase the surface of the convection superheater in order to obtain the final steam temperature of 925 deg. F. at the full output of the boiler.

Had this unit been of the usual design with a single furnace and convection superheater, but with gas entering the superheater at about 1850 deg. F. at full rating, it would have been necessary to install a much larger convection superheater in order to maintain a constant steam temperature of 925 deg. F. by by-passing the gases around the superheater at the higher rates of steaming.

Operation

Initially it took 24 hr. to bring the unit up to design pressure, but now it is customary to take 12 hr. to bring the boiler from zero to line pressure. It is believed that this can be accomplished in 8 hr. without imposing any undue stress on the pressure parts.

The normal procedure of firing the boiler when starting is as follows: Two oil torches are ignited in the waterwall furnace and one in the superheater furnace. The latter torch is kept near the division wall and remote from the superheater. When a pressure of 230 psi is reached, the unit delivers steam to the low-pressure header and coal is then fired through the two center burners in the waterwall furnace.

At this time about 100,000 lb. of steam per hr. is being made and the pressure is increased at a rate of 200 psi per hr. until the pressure reaches 1200 psi. Additional coal burners are then fired in the waterwall and superheater furnace and the pressure and temperature of the steam leaving the superheater adjusted to meet the requirements of the turbine. The boiler is then connected to the high pressure header.

The unit as a whole is kept clean by the use of soot blowers and a small amount of hand lancing and there has been no loss of capacity or outage of this unit due to slagging. One man per shift does all of the soot blowing and hand lancing and empties the soot hoppers. The slag-screen tubes above each furnace are lanced by hand as often as may be required, which is between once or twice a shift, depending upon the kind of coal being burned.

The amount of hand lancing on the convection heating surface of the boiler and superheater is small. In this region dry ash builds up on the downstream side of the heating surface until most of it falls from the tubes without the aid of steam jets.

This boiler operates with an efficiency of about 86 to 88 per cent. The CO_2 in the gas going to the air heater is normally over 15 per cent. Measurements of the impurities in the steam leaving the boiler indicate that the total solids varies from 0.5 to 0.6 ppm with total solids in the boiler water varying from 200 to 1400 ppm.

CLINKERING AND SLAGGING

Investigation reveals that a given coal is not uniform but consists of several fractions each with different physical properties, ash content and characteristics. At least in the initial stages of clinker or slag formations, the action is dependent upon two or more kinds of ash acting independently of each other often with little relation to the composite sample

By G. B. GOULD, Pres.
Fuel Engineering Co. of N. Y.
New York, N. Y.

GREAT CHANGES have taken place in the way coal is burned under steam boilers in a span of less than 20 yr. New methods of burning coal and improvements in old methods, accompanied by increased rates of combustion have made it progressively more important to look deeper into the nature of coal and to devise new ways to examine and measure its properties.

Higher rates of combustion and closer attention to furnace efficiency has stimulated greater interest in the size distribution of coal, as shown by screen analysis. While these and other new laboratory tools of fuel engineering have added tremendously to the knowledge of coal, their increasing number has made it much more difficult, if not impossible, for anyone without special training and experience in this field to effectively use them. It is not that coal selection has become more complex, but our increasing knowledge makes its inherent complexity more apparent.

Generalizations Not Enough

For example, it has been convenient to accept the percentage of ash and the softening temperature of the ash as the very simple and direct measurements, which they appear to be. Used in that way they are very useful, but it is easy to overlook the fact that both of these determinations represent generalizations. The quality of ash and its physical properties

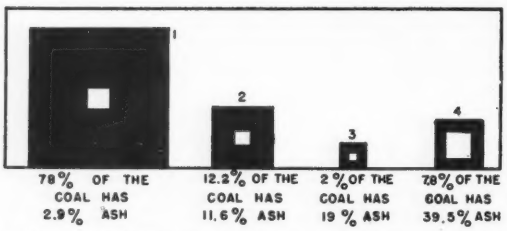


Fig. 1. Distribution of ash in Coal F crushed to ¼ in. Ash in Fractions 1, 2 and 3 is refractory, most of it with an I.D.T. above 2700 deg. F. Ash in Fraction 4 is friable with an I.D.T. of from 1980 to 2100 deg. F. The ash softening temperature of the composite ash is 2460 deg. F., the I.D.T. 2360 deg F.

account for most of the major problems in boiler plant design and operation.

With the changing conditions to which coal is subjected in the furnace, it has become increasingly important to get behind the screen of these generalizations, and find out whether or not a coal contains different kinds of ash, and if so, how they are distributed in the coal. During the past 2 yr., our staff has been conducting a series of investigations[1], prompted by a line of reasoning which can be simply explained in this way.

If the pieces of coal can be physically separated into classes of material, which differ among themselves in the percentage of ash they contain, and if the ash in the different classes of fuel particles differs in its physical properties, then it follows that in the furnace we are not dealing with a composite ash, but with two or more distinct kinds of ash, which are capable of acting independently of each other, at least in the initial stages of clinker or slag formation.

Results demonstrated that this is precisely the situation in the case of a group of coals which are typical of a large part of the production in Pennsylvania and from the data it may be deduced that this is probably true for all coals, in the Appalachian area, which have a softening temperature of the composite ash above 2400 deg. F.

Ash Softening Temperature and Fusible Ash

Two methods of investigation were followed, one designed to reveal the distribution of the ash in coal as it would reach the fuel bed of an underfeed stoker, the other to determine how the ash is distributed among the particles of pulverized coal. For the stoker study, nut-slack coal was first crushed to a top size of approximately ¼ in. to allow for the crushing action of the stoker feed. The coal was then divided into 28 portions, according to the size and density of the pieces by a combination of gravity and screen separation. Each of these 28 portions was tested for the per cent of ash, and the ash in each portion was tested for its fusing characteristics in an electric muffle furnace, within which was maintained an artificial atmosphere of pre-determined composition to conform to the A.S.T.M. Standard Specifications.

What was found for two or three of the coals tested in this way will suffice to illustrate clearly the significance of this method of testing. Figure 1 illustrates graphically how the ash was found to be distributed in a coal having a softening temperature of the composite ash of 2460 deg. F. It will be seen at a glance that a large part of the ash is highly refractory and widely distributed through the coal while the fusible ash is concentrated in less than 8 per cent of the coal.

Coal B[2] tested by the conventional methods had 8.4 per cent of ash, the ash softening temperature of this composite ash was 2800 deg. +, and the initial deformation temperature was 2780 deg. F.[3] But when this coal was taken apart, it was found that 52.5 per cent of the coal consisted of particles which averaged only 3.3 per cent of ash, 37.8 per cent consisted of coal particles which averaged 10.4 per cent of ash, and 6.3 per cent consisted of particles which contained 20.4 per cent of ash.

All of the ash in these portions which aggregated 96.6 per cent of the coal, had an I.D.T.[3] of 2800 deg. + F. The remaining 3.4 per cent of the coal, consisted of particles which averaged 48.8 per cent of ash, and this ash varied from 2080 to 2440 deg. F. I.D.T., nearly all of it being under 2300 deg. F. Stated in another way, 20 per cent of the ash in this coal consisted of low-fusing material and was carried in concentrated form by physically separable particles, which constituted only a little more than 3 per cent of the coal.

Kinds of Ash

One of the most interesting facts revealed by this study is that among the coals rated at 2400 deg. F. and higher, the ash is composed of two distinct classes of material, one fusible at a lower temperature (usually under 2200 deg. F.), and the other highly refractory. And in the main, these two kinds of ash are found in separate pieces of coal, instead of being intimately combined in the same piece. A very small part of the ash is found in some of the 28 portions of the coal, with a I.D.T. between 2300 deg. F. and 2600 deg. F., which represents small quantities of the two kinds of ash in combination in individual pieces of coal.

This concept of two separate kinds of ash, one easily fusible and the other highly refractory, presents quite a different view of the mechanism of clinker formation, especially in its early stages, from

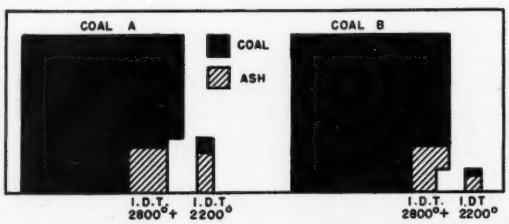


Fig. 2. Comparison of two pulverized coal samples. The composite A.S.T. of both samples is 2800 deg. F., the I.D.T. 2800 deg. F. for coal A and 2780 deg. F. for coal B.

[1]A detailed account of these investigations will be found in the A.I.M.E. Technical Paper No. 1175 "Free Fusible Material in Coal Ash as an Index of Clinker and Slag Formation" by G. B. Gould and H. L. Brunjes, December 1939.

[2]The coals referred to in the text and Fig. 3, are all Pennsylvania coals from the following seams and counties: A, Lower Freeport, Jefferson; B, Pittsburgh, Westmorland; C, Upper and Lower Freeport, Indiana; E. Lower Freeport, Clearfield, and F, Thick Freeport, Allegheny.

[3]In the laboratory determination of the fusibility of coal ash, three stages in the melting process are observed; (1) the initial deformation temperature, which is the point at which the first evidence of softening is observable; (2) the softening temperature, an arbitrary point at which the softening has proceeded far enough so that the cone has assumed a globular shape, (which is the temperature customarily referred to as the "softening" or "fusing" temperature of the ash); and (3) the fluid temperature, which is the point at which the ash flows. In this study of the different classes of material in coal ash, the initial deformation temperature (I.D.T.) is used, because that is the lowest temperature at which any portion of the ash becomes sticky, and is in a condition to adhere to furnace or boiler surfaces, or to other particles of ash with which it may come in contact.

that which one gets by assuming that all of the ash is a uniform mixture of materials having a definite softening temperature, as indicated by the established laboratory method.

Ash and Clinker Formation

For example, in coal A, which would have an ash softening temperature rating of 2800 deg. F. +, one-fifth of the ash is easily fusible material, which would melt at low temperatures and act as a binder for the more refractory ash, which under many conditions would never melt at all. This proportion of 1:4 of fusible and refractory ash is not serious from a clinker forming standpoint, but it illustrates why and how some clinkers are almost always formed, when a coal having an ash of very high softening temperature is burned, even at moderate rates of combustion.

But as the proportion of free fusible material rises, the probability of the formation of larger masses of denser clinkers increases. In general, as the proportion of fusible material increases, the softening temperature of the composite ash declines, but this is not always true. This seems to explain why the customary determination of ash softening temperature is usually a good index of clinkering tendencies, and also why occasionally it seems to be unreliable.

For example, in Coal D, the ash softening temperature for which was 2580 deg. F., there was found to be 38.2 per cent of its ash with an I.D.T. below 2200 deg. F. In Coal F, however, the ash softening temperature of which was 2460 deg. F., more than 100 deg. F. lower than Coal D, only 31.9 per cent of its ash had an I.D.T. below 2200 deg. F. It is in discriminating among coals which have an ash softening temperature in the range from 2400 to 2700 deg. F., that this method of examination is likely to be most valuable.

Incidentally, the fact that the ash in a large group of coals is composed of two separate materials, differing widely in their softening temperatures, explains why the softening temperature of the ash varies among different shipments from the same mine over a range of 200 deg. F. or more. The resulting softening temperature of the composite ash will obviously vary according to the proportions of these two materials which happen to occur in any one lot. The fusible material is quite likely to come from parting in the seam, or from the floor or roof materials in the mine, and variations which would be scarcely noticed in mining can materially change the proportion of free fusible material in the coal.

In attempting to forecast the slagging characteristics of coals in pulverized coal furnaces, the conventional method of determining the softening temperature of the composite ash has been found less reliable than as an index of clinkering on a solid fuel bed.

Pulverizing

When similar methods of separating the fusible ash are applied to pulverized coal, there is a sharper division between the fusible and refractory material, than in the case of the larger sizes, and there is a much greater degree of concentration of the fusible material. For example, when Coal B was pulverized to minus 200 mesh, 98.5 per cent of the coal contained ash which had an I.D.T. of 2800 deg. F. The remaining 1.5 per cent of the coal contained all of the fusible ash, having an I.D.T. of 2060 deg. F., and constituting 12.6 per cent of all of the ash in the coal.

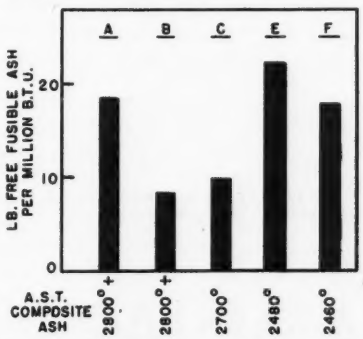


Fig. 3. Comparative ash content and composite A.S.T. of five 2 coal samples.

Distribution of the ash in Coal B is shown graphically in Fig. 2, together with that for Coal A, which also has a softening temperature of its composite ash of 2800 deg. F. +. but contains a much larger proportion of fusible ash. Therefore, even a coal, with a rating of 2800 deg. F. softening temperature of the composite ash, there may be a substantial quantity of very easily fusible ash entering the furnace in concentrated form, and two coals, both in this class, may differ greatly in slag forming material.

Slag Forming Material

In a group of coals which ranged from 6.3 to 9.8 per cent ash, it was found that from 80 to 90 per cent of the coal enters the furnace in the form of particles that contain 6 per cent of ash or less. At the other extereme, from 1.5 per cent to 4 per cent of the material which enters the furnace consists of particles that contain from 60 to 70 per cent of ash, all of which is easily fusible. The presence of 4 per cent of this kind of material, as compared with 1.5 per cent increases the proportion of free fusible ash from 15 per cent or less to 30 per cent or more of the total ash. The relative quantities of fusible ash per million B.t.u. in five coals are shown graphically in Fig. 3. Notice that coals A and F, differing widely in the softening temperature of the composite ash, contain practically the same amount of free fusible material.

In a pulverized coal furnace, the fusible ash melts and forms a sticky film on all the surfaces with which it comes in contact.

Refractory ash adheres to this film in varying proportions, and whether the two materials ultimately combine chemically, enter into solid solution, or merely are mixed physically to form an aggregate, all of which would depend upon the position in furnace and the temperature conditions at that point, slags having a wide range of physical properties are produced. In general, it would be expected that as the distance from the burner increases, the proportion of fusible material in the slag will decline, while the proportion of refractory material will increase.

Fusible Ash Liberated

It will have been noticed that when separated in pulverized form, Coal B apparently contains less free fusible ash than in the form of crushed nut-slack. The reason for this is that as coal is reduced in size by crushing or grinding, there is a progressive separation of the different classes of material. The portions of the crushed coal which contained low-fusing ash, evidently also contained a small proportion of refractory material, which was released, when the coal was pulverized.

In most cases, this seems to be true, but in one case, the reverse was true. In that coal the free fusible material rose from 8 per cent of the total ash in the crushed coal, to 26 per cent of the ash in the pulverized coal. This coal, so far unique in our experience, contained a very substantial proportion of fusible

material in its ash, but it was so intimately associated with the refractory ash, and so evenly distributed in the coal structure, that it was not released until the coal was pulverized. Its presence in the crushed coal could be suspected, however, from the fact that a relatively small proportion of the ash had an I.D.T. of 2800 deg. F. and a relatively large proportion was found in the range of 2600 to 2800 deg. F.

Refractory Material

One coal having an ash softening temperature of 2140 deg. F. was tested in pulverized form. No refractory material could be found in separable portions of this coal, the highest I.D.T. for the ash in any fraction was 2360 deg. F. This represents an entirely different class of coal from the standpoint of either clinker or slag formation, for the entire ash melts at low temperatures. In a pulverized coal furnace, this type of coal might be expected to produce a more uniform type of slag at all points in the furnace, than those coals, such as have been previously discussed, which contain a substantial proportion of refractory ash. The investigation has not gone far enough to indicate whether or not the results are typical of all coals having a low softening temperature of the composite ash.

In addition to the fact that coal ash may consist of two or more distinct kinds of ash, it is also necessary to take into account the fact that certain kinds of coal ash (high in iron), ordinarily rated as easily fusible, melt at a much higher temperature in an oxidizing atmosphere, while other kinds of fusible ash melt at the same temperature in either a reducing or oxidizing atmosphere. By physically separating the ash into its component parts, it becomes possible to determine which kind of free fusible material is present, and thus forecast its behavior under different kinds of furnace conditions.

This method of testing, which is designed to physically separate and quantitatively measure the free fusible material in coal ash, throws a new light on the mechanism of clinker and slag formation. It provides a basis for predetermining the relative clinkering characteristics of different coals of about the same ash-softening temperature, and of quantitatively measuring the slag-forming material in pulverized coal, and when it is necessary, it is possible in this way to discriminate more closely among coals for more exacting requirements.

GAGING LAMINAR PRODUCTS

New standard proposed based on volume of water at 4 deg. C.

By Howard H. Pitts

FLAT STOCK metal products are necessarily made to certain standard thicknesses for the sake of simplicity. Flat wire, hoop, band, strip, and spring steels are rolled to the Birmingham, or the Stub's gage, as it is otherwise known. Brass, copper, and steel tubing is also formed to this gage, while other non-ferrous laminar stock is made in the so-called American Wire, or the otherwise Brown and Sharpe gage. These non-ferrous products are also rolled to fractional-inch sizes. Sheet iron and steel are usually rolled to the United States Standard, though some mills will furnish it in the Birmingham gage, unless specified differently. Plates are usually made in fractional thicknesses, and 3/16 in. seems to be the standard line of demarcation between plates and sheets. Engineering handbooks and distributors' catalogs will give more complete data on the usage of the various gages, some of which are also used in the sizing of both ferrous and non-ferrous wire products.

It should be noted that the greater number of present-day gages bear two or three names, any one of them being used by engineers, draftsmen, and purchasers to designate the same particular gage. The name to be used will depend upon the preferences and practices of the persons or companies doing the ordering or specifying. In order to avoid confusion, due to the multiplicity of gaging data, the manufacturers of rolled stock invariably request their customers to mention both the number and name of the gage, or else to specify the thickness of the stock in decimals of an inch. In this respect, some engineering offices not only give the gage number and name on drawings and bills of material, but also specify the decimal thickness. This is done to offset any possible chance of error.

Purpose

The plant engineer is not exempt from the confusion induced by the different ways in which the gages of flat stock are noted. There comes a time when he must requisition material of a certain thickness, and it is important that he make no mistake in the gage. Accuracy is the very essence of the engineering professions, yet, by the very nature of his work, the plant engineer is not always as familiar with such details as the designing engineer. Due to these occasional inaptitudes, he may fail to use the correct gage designation in his requisition. Of course, the material may be of use regardless of the correctness of gage; this will depend upon the usage to which the stock is put. Nevertheless, the possible confusion in ordering such material brings out the moot question: *Why such a variety of differing gages?*

The fact is that the present system of gaging is a decided simplification of an older, haphazard order of things. An attempt to answer the immediate query, however, is made by submitting a proposal for a new gage, the American Laminar Gage, as follows: It might be the answer to one of the problems confronting the Committee on Wire and Sheet Metal Gages of the American Standards Association. It is not disruptive to existing rolling mill practices when viewed from the progressive aspect.

The purpose of the suggested gage is, firstly, to reduce the existing number of different gages to a single basic standard, by

which the unit weights of various rolled products can be simply and correctly established for any thickness; secondly, to simplify engineering design procedure and rolling mill practices by eliminating certain inconsistences and confusion of data.

The Gage

The proposed American Laminar Gage is a combined dimensional and weight gage suitable for application to any metal or other solid substance. It is based upon a volume of pure water at 4 deg. C., one meter long, one decimeter wide and one centimeter thick, as shown in the diagram immediately below. The metric system has been used because it lends itself more readily to adaptation, and because it is a better system of measurement for engineering and scientific purposes.

The present United States Standard is a weight gage based upon weights per square foot and approximate thicknesses, which are primarily based upon the weights of 489.6 lb. per cubic foot for steel and 480 lb. for iron. The Birmingham and other gages are dimensional. Comparison of these with the proposed standard may be made by referring to the tables and notes on gages to be found in engineering handbooks. Reference may also be made to Circular No. 47 of the Bureau of Standards on "Units of Weight and Measure."

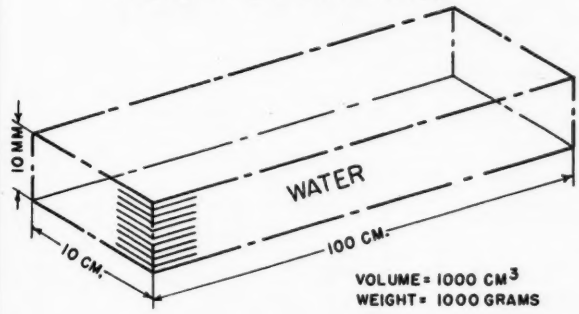
The proposed gage will not hinder the rolling of metals to present standards where desirable to continue doing so. In fact, the rolling of stock would be limited only by the requirements of trade, rather than the ten basic thicknesses found in Table I. Being a decimal gage the basic standard can be expanded to meet all practical demands. Shifting the decimal points to left or right will give a greater variety of gages than shown.

Attention is directed to the fact that dimensional variations between equivalent *proposed* and *fractional* gages are so very slight as to be negligible. For instance, 1/64 in. equals 0.015625 in. while 0.4 mm equals 0.01575 in., the difference being 0.000125 in. Weight variations will also be correspondingly small. The deviation to be found between weights in the basic standard at 4 deg. C. and those at 60 or 62 deg. F. is of no consequence in practice. A basic standard calculated at either of the latter temperatures would only serve to complicate matters.

Gage Numbers

Any system of numbering can be used to denote gages, or, the actual thicknesses in millimeters might be used as gage numbers. It may be found preferable, though, to use the actual dimensions of the stock in designating its gage. Millimeters or decimal inches could be used, whichever would serve the occasion of its use.

AMERICAN LAMINAR GAGE



TABLE

BASIC STANDARDS

THICKNESS		WEIGHT PER 1000 CM²		WEIGHT PER 144 IN²	
MM	INCHES	GRAMS	POUNDS	GRAMS	POUNDS
t	t'	W_g	W_p	W'_g	W'_p
10	.3937	1000	2.20462(3)	929.032(1)	2.04816(2)
9	.3543	900	1.98416	836.129	1.84334
8	.3150	800	1.76370	743.223	1.65453
7	.2756	700	1.54324	650.323	1.43372
6	.2362	600	1.32277	557.419	1.22890
5	.1968	500	1.10231	464.516	1.02408
4	.1575	400	0.88184	371.613	0.81927
3	.1181	300	0.66139	278.710	0.61445
2	.0787	200	0.44092	185.806	0.40963
1	.0394	100	0.22046	92.903	0.20482

1000 CM² = 155 SQ. IN. 1000 CM³ = 0.03531445 CU. FT.

(1) $\frac{144}{155}$ X 1000 = 929.032258 GRAMS

(2) 2.04816527 POUNDS = (1) X (3) ÷ 1000

(3) 2.20462234 POUNDS = 1000 GRAMS

COMPILED BY HOWARD H. PITTS

Explanation of Table

Basic Weight

(Col. W_g) To find the basic weight in grams per unit area (1000 cm²) for any thickness in millimeters, multiply that thickness by 100. (For instance, from the table, a thickness of 9.00 mm multiplied by 100 equals 900 grams.)

(Col. W_p) To find the basic weight in pounds per unit area (1000 cm²), multiply the thickness in millimeters by 0.220462234. (9 times 0.220462234 equals 1.98416. See table.)

(Col. W^1_g) To find the basic weight in grams per square foot, multiply the thickness in millimeters by 92.9032258. (9 times 92.9032258 equals 836.129. See table.)

(Col. W^1_p). To find the basic weight in pounds per square foot, multiply the thickness in millimeters by 0.204816527. (9 times 0.204816527 equals 1.84334. See table.)

Weight Per Unit Area

(a) To find the weight per unit area of any metal of any given thickness, multiply the basic weight by the specific gravity of the metal.

Specific gravity = S

Weight in grams per 1000 cm² = $w_g = SW_g$

Weight in pounds per 1000 cm² = $w_p = SW_p$

Weight in grams per sq. ft. = $w^1_g = SW^1_g$

Weight in pounds per sq. ft. = $w^1_p = SW^1_p$

(b) To find the weight in pounds per square foot of any metal of any thickness in inches, use the following formula:

Weight in lb. per sq. ft. = $w^1_p = 5.2024St^1$

Where $w^1_p = 2.54(2.048St^1)$, and where S = specific gravity and t^1 = thickness in decimal inches.

PENSACOLA DAM COMPLETED

New 80,000 hp. power development on the Grand River goes into operation with the longest known multiple-arch dam. Dam built under a $11,563,000 loan and a grant of $8,437,000 in 1937

By H. D. ROBARDS

COMPLETION of the combination hydroelectric-flood control dam on Grand River in Northeast Oklahoma, known as the Pensacola Project, brings several salient features to notice. It is the longest known multiple-arch dam. Hollow buttresses were used. Operation of all auxiliaries is electrified, 99 per cent. It is a dry dam and there has been built into it much "eye appeal."

History of the project extends back 50 yr. when local men began dreaming of a dam, and includes five interest peaks when construction seemed assured. One was quite dramatic; Insull men arrived on the scene ready to go to work just before Insull's utilities empire collapsed. Government approval for the project as a hydroelectric unit alone was not whole-hearted; combination of that, flood control and recreational purposes gave it the clear signal for a PWA loan of $11,563,000 and grant of $8,437,000 in 1937.

Operating unit is the Grand River Dam Authority, an Oklahoma body composed of Ray McNaughton, Miami, Chairman; R. P. Colley, Tulsa; Earl Ward, Pryor; M. Duncan, Muskogee, and M. M. Valerius, Jay. T. P. Clonts is general manager, with offices in Vinita. Engineering: Holway & Neuffer, Tulsa and Albuquerque, with W. R. Holway, chief engineer, resident on the construction. Preliminaries were begun shortly after governmental approval in 1937, but the active work began in 1938 with the general contract for dam and powerhouse being awarded to

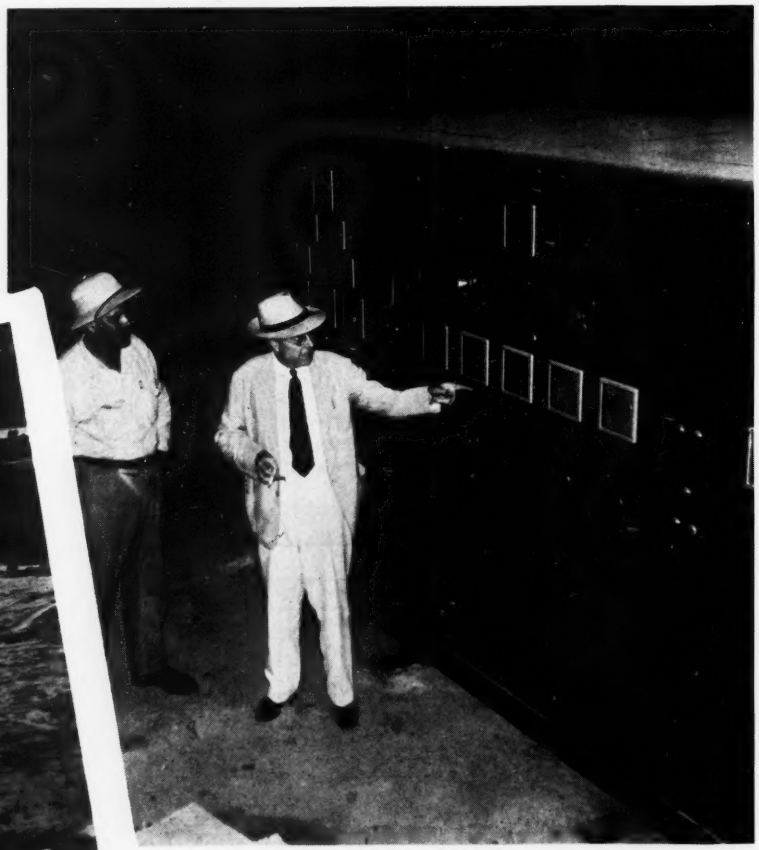


Fig. 1. Left. The Pensacola dam on the Grand River is said to be the longest multiple-arch dam in existence. This view shows the intake structure, switchyard and powerhouse in the foreground

Fig. 2. Above. A view in the powerhouse during construction showing one of the actuator cabinets. There are two of these units each one serving two generators

Fig. 3. The main generator room showing the four 20,000 hp., 150 r.p.m. Allis-Chalmers generating units

Massman Construction Company of Kansas City.

Size: Length of dam and spillways, 6,565 ft.; width, 20 ft. Multiple arch section, 51 arches, clear span 60 ft. each, length, 4,284 ft. Main spillways, 860 ft. long, 21 Taintor gates, weir at 730 ft. elevation, two 60-ton hoists; east spillways, 860 ft., 21 Taintor gates, 15 ft. x 37 ft., weir at 740 ft. elevation, 2 30-ton hoists. Top, 20 ft. roadway and 4 ft. walk at 763.5 ft. elevation.

Uplake side of dam, because of the 52 hollow buttresses, each 24 ft. wide and 150 ft. high in river bed, resembles a row of concrete grain elevators, tilted. Downlake side resembles a row of outdoor band shells of immense proportions.

Powerhouse and intake structures are located at west or "cliff" end of dam. Four 15 ft. penstocks, each vented by 30 in. tube, run from uplake intake structure to powerhouse for four 20,000 hp., 150-r.p.m. Allis-Chalmers turbines driving four 16,000 kv-a., 13,800 v., 60 cycle, 3 phase, conventional type Westinghouse generators. A 750 hp. turbine and 625 kv-a. generator driven from 30 in. penstock provide auxiliary "house supply." Powerhouse is built for future addition of 2 of the 20,000 hp. units; a 100-ton traveling crane is installed for servicing and future installations.

Powerhouse on river bed level is 72 ft. wide, 279 ft. long and 80 ft. high, not including relay house and elevator head built on bluff level. Personnel entrance is through passenger elevator down 100 ft. in bluff to 12 ft. x 12 ft. tunnel, 200 ft. to powerhouse floor. This tunnel also houses cable racks, 1,000,000 C. M. cable through tunnel, up behind elevator shaft to the switchyard on the bluff.

Powerhouse floors may be distinguished as basement, turbine, generator and mezzanine floors. Principal use for the basement is for pumps and tanks for purifying and reclaiming cooling-oil.

Turbine floor installations include water supply system for drinking and sanitary supply, compressed air tank and automatic compressor, battery and blower rooms. Water system includes mixing, settling and filter basins. Each generator is served by a 65,000 c.f.m. blower, air filtered through oil. A meter to tell when filter oil needs changing or filter needs cleaning is mounted near each blower. Air circulation: From grilled intakes outside at mezzanine level to blower rooms, through adjustable louvres and out at turbine floor level, through four-way intakes to the generators, upward to ceiling, out through long narrow ventilators in roof.

Generator floor offers clear upview of generators with the exciters for exciters atop. Space for future additions looms large here. Two actuator cabinets, each handling two turbines, each completely motorized and fitted with automatic safety locks. A turbine cannot be shut down at the control board until three switches, including one in the switch tower, have been opened. These cabinets are located between the row of generators; opposite is the row of three control boards, one for the house auxiliaries, one for the generator and feeder control from where all switching is done in the switchyard by remote control and one for the voltage regulators.

A chemical laboratory for water supply and other uses is on the main floor, east end; water sup-

(*Continued on Page* 93)

DERIVATION OF ELECTRICAL FORMULAS

By C. O. von Dannenberg

IN AN ARTICLE on the subject of motor testing published in the September 1940 issue of this publication the author made use of certain formulas for determining power factor and reactive volt-amperes. The publication of these formulas brought forth a number of requests for further information regarding their derivation. In the discussion which follows this information is given together with a number of examples illustrating the applicability of these equations.

For convenience, the formulas in question are reprinted here, as follows:

1. Total watts (or kw.) input are $W_1 + W_2$
2. Power factor (per cent) is 50 $\sqrt{\frac{(I+A)^3}{I+A^3}}$ where A is W_1/W_2.
3. Total volt amperes (or kv-a) are $2\sqrt{W_1^2 + W_2^2 - W_1 W_2}$

A check of 3 can of course be made by dividing I by 2.

4. Total reactive volt-amperes (or RKVA) are $\sqrt{3}\ (W_2 - W_1)$

While all the formulas are developed from well known fundamental detail given in elementary text books and include in their manipulation the algebraic and trigonometrical processes taught in high schools their value and use has been much retarded through not being presented in their final form so as to be directly applicable. This is particularly true of the formula for power factor which is usually expressed in the form tan θ equals

$$\frac{\sqrt{3}\,(W_2 - W_1)}{(W_2 + W_1)}$$

which makes necessary the availability of a trigonometrical table from which the cosine (power factor) value corresponding to the tangent can be obtained. So far as is known to the author the formula for KV-A and RKV-A are not in general use or given in text books or engineering handbooks.

Given a 3-phase circuit, 1-2-3 (Fig. 1) with the sequence (incorrectly termed rotation) in the same

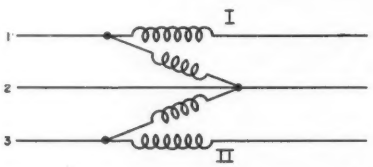


Fig. 1. Diagrammatic 3 ph. circuit, I and II are meter elements

numerical order and meter elements connected in the conventional way shown, calling the meter elements I and II, we can indicate the system vectorially as follows:

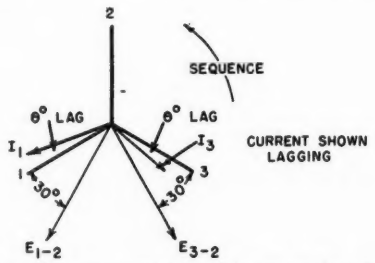


Fig. 2. Vector representation of the system shown by Fig. I

The currents in the respective lines are indicated as I_1 and I_2 while the voltages are indicated as $E_{1\text{-}2}$ and $E_{3\text{-}2}$ associated with I_1 and I_2 respectively. We may then write

$$(1) \qquad W_1 = E_{1\text{-}2}\, I_1 \cos (30 + \theta)$$

$$(2) \qquad W_2 = E_{3\text{-}2}\, I_2 \cos (30 - \theta)$$

It is clear that angle $30 + \theta$ is greater than $30 - \theta$, hence W_1 is less than W_2.

For a balanced circuit $E_{1\text{-}2}\, I_1$ equals $E_{3\text{-}2}\, I_2$ hence, we can divide (1) by (2) and write

$$(3) \qquad \frac{W_1}{W_2} = \frac{E_{1\text{-}2}\, I_1 \cos (30 + \theta)}{E_{3\text{-}2}\, I_2 \cos (30 - \theta)} = \frac{\cos (30 + \theta)}{\cos (30 - \theta)}$$

Expanding the right hand side of (3) we get

$$(4) \qquad \frac{W_1}{W_2} = \frac{\cos 30 \cos \theta - \sin 30 \sin \theta}{\cos 30 \cos \theta + \sin 30 \sin \theta}$$

Dividing the numerator and the denominator of the right hand side of (4) by cos 30 cos θ, we get

$$(5) \qquad \frac{W_1}{W_2} = \frac{1 - \tan 30 \tan \theta}{1 + \tan 30 \tan \theta}$$

Solving for tan θ, we get,

$$(6) \quad \tan \theta = \frac{\sqrt{3}\,(W_2 - W_1)}{(W_2 + W_1)}$$ which is found in all text books but which requires a trigonometrical table for its solution.

From elementary trigonometry we have

$$\sec^2\theta = 1 + \tan^2\theta$$

since $\cos\theta = \dfrac{1}{\sec\theta}$ hence

$$(7)\quad \cos^2\theta = \frac{1}{\sec^2\theta} = \frac{1}{1+\tan^2\theta}$$

If then, we substitute the value of $\tan\theta$ from (6) in (7) we get,

$$\cos^2\theta = \frac{1}{1+\left(\dfrac{\sqrt{3}\,(W_2 - W_1)}{W_2 + W_1}\right)^2}$$

$$= \frac{(W_2+W_1)^2}{(W_2+W_1)^2 + 3\,(W_2-W_1)^2}$$

$$= \frac{(W_2+W_1)^2}{W_2^2 + 2W_2W_1 + W_1^2 + 3W_2^2 - 6W_2W_1 + 3W_1^2}$$

$$(8)\qquad = \frac{(W_2+W_1)^2}{4\,W_2^2 - 4\,W_2\,W_1 + 4\,W_1^2}$$

then $\cos\theta = \frac{1}{2}\sqrt{\dfrac{(W_2+W_1)^2}{W_2^2 - W_2\,W_1^2 + W_1^2}}$

If the numerator and the denominator under the radical are multiplied by $W_2 + W_1$ we get,

$$(9)\ \cos\theta = \tfrac{1}{2}\sqrt{\frac{(W_2+W_1)^3}{W_2^3 + W_1^3}}$$

If (9) is multiplied by 100 to change its value to per cent and we let $\dfrac{W_1}{W_2} = A$ we get

$$(10)\ \text{P. F. (per cent)} = 50\sqrt{\frac{(1+A)^3}{1+A^3}}$$

Assume P. F. = 100%, then $W_2 = W_1$ and A is 1

$$\text{or P. F.} = 50\sqrt{\frac{(1+1)^3}{1+1^3}} = 50\sqrt{\frac{(2)^3}{2}}$$

$$= 50\sqrt{\frac{8}{2}} = 50\sqrt{4} = 50 \times 2$$

$$= 100$$

If P. F. = 50%, then $W_1 = 0$ and $A = 0$ and we get

$$\text{P. F.} = 50\sqrt{\frac{(1+0)^3}{1+0^3}} = 50\sqrt{\frac{1}{1}} = 50 \times 1 = 50$$

Q E D

Refer again to equations (1) and (2). Expanding, we have

$$(11)\ W_1 = E_1 I_1 \cos 30 \cos\theta - E_1 I_1 \sin 30 \sin\theta$$

$$(12)\ W_2 = E_2 I_2 \cos 30 \cos\theta + E_2 I_2 \sin 30 \sin\theta$$

With a balanced circuit $E_1 I_1 = E_2 I_2$, hence by adding (11) and (12) we get

$$W_2 + W_1 = E\,I \cdot 2 \cos 30 \cos\theta$$

$\cos 30 = \dfrac{\sqrt{3}}{2}$ hence

$$(13)\ W_2 + W_1 = E\,I\,\frac{\sqrt{3}}{2} \times 2\cos\theta = \sqrt{3}\,E\,I\cos\theta$$

which is the conventional formula for the total power in a balanced 3 phase circuit.

Subtracting (11) from (12), we get

$$W_2 - W_1 = E\,I \cdot 2 \cdot \sin 30 \sin\theta$$

$\sin 30 = \frac{1}{2}$ hence

$$W_2\,W_1 = E\,I \cdot 2 \cdot \tfrac{1}{2} \sin 30 \sin\theta = E\,I \sin\theta$$

Reactive KVA being $\sqrt{3}\ E\,I \sin\theta$, we can write

$$\text{Reactive KVA} = \sqrt{3}\ (W_2 - W_1)$$

If P. F. = 100, then $W_2 = W_1$ and we have

$\text{RKVA} = \sqrt{3}\ (\frac{1}{2} - \frac{1}{2}) = \sqrt{3} \times 0 = 0$ which is as it should be.

If P. F. = 50%, $W_1 = 0$ and we have (since one meter reads zero)

$$\text{RKVA} = \sqrt{3}\ (1-0) = \sqrt{3} \text{ or } 1.73.$$

With P. F. = 50%, then total KVA will be $\dfrac{1}{0.5} = 2$

$$\text{RKVA} = \sqrt{(2)^2 - 1^2} = \sqrt{3} = 1.73$$

Q E D

$$\text{KVA} = \sqrt{(\text{KW})^2 + (\text{RKVA})^2}$$

$$= \sqrt{(W_2+W_1)^2 + [\sqrt{3}\,(W_2 - W_1)]^2}$$

$$= \sqrt{W_2^2 + 2W_2W_1 + W_1^2 + 3W_2^2 - 6W_2W_1 + 3W_1^2}$$

$$= \sqrt{4W_2^2 + 4W_1^2 - 4W_2W_1}$$

$$\text{KVA} = 2\sqrt{W_2^2 + W_1^2 - W_2W_1}$$

Q E D

If P. F. = 100 then $W_2 = W_1$ and we have

$$\text{KVA} = 2\sqrt{(\tfrac{1}{2})^2 + (\tfrac{1}{2})^2 - \tfrac{1}{2} \times \tfrac{1}{2}}$$

$$= 2\sqrt{\tfrac{1}{4} + \tfrac{1}{4} - \tfrac{1}{4}}$$

$$= 2\sqrt{\tfrac{1}{4}} = \frac{2}{2} = 1$$

At 50% P. F. $W_1 = 0$ then

$$\text{KVA} = 2\sqrt{1+0+0} = 2 \times 1 = 2$$

Q E D

Supplement

$$KVA = \frac{KW}{PF} = \frac{W_2 + W_1}{\frac{1}{2}\sqrt{\frac{(W_2 + W_1)^3}{W_2^3 + W_1^3}}}$$

$$KVA^2 = \frac{(W_2 + W_1)^2}{\frac{1}{4}\frac{(W_2 + W_1)^3}{W_2^3 + W_1^3}} = \frac{4\,(W_2^3 + W_1^3)(W_2 + W_1)^2}{(W_2 + W_1)^3}$$

$$= \frac{4W_2^3 + 4W_1^3}{W_2 + W_1}$$

$$KVA = 2\sqrt{\frac{W_2^3 + W_1^3}{W_2 + W_1}} = 2\sqrt{W_2^2 + W_1^2 - W_2W_1}$$

as before Q E D

If P. F. $= 86.6\%$, $\theta = 30°$

$30 + \theta = 30 + 30 = 60$

$30 - \theta = 30 - 30 = 0$

Then

$\cos(30 + \theta) = 0.5$ and $\cos(30 - \theta) = 1$

$$\text{or } W_2 + W_1 = 1.5 \text{ hence } W_2 = \frac{2}{3}W_1 = \frac{1}{3}$$

Substituting

$$KVA = 2\sqrt{\left(\frac{2}{3}\right)^2 + \left(\frac{1}{3}\right)^2 - \frac{2}{3} \times \frac{1}{3}}$$

$$= 2\sqrt{\frac{4}{9} + \frac{1}{9} - \frac{2}{9}} = 2\sqrt{\frac{3}{9}}$$

$$= \frac{2\sqrt{3}}{3} = \frac{3.464}{3} = 1.154$$

Proof

$$\frac{KW}{PF} = \frac{1}{0.866} = 1.154$$

The use of the formulas involves situations requiring care in their application. This is particularly true when the power factor is slightly higher or lower than 50 per cent and the load is of such a nature that one meter element may stop altogether or move only part of a revolution in either direction. When the tester is assured of the correctness of the meter connections only careful observation will indicate whether the value of the smaller element (W_1) reading shall be positive (t) or minus (—). It may also at times be necessary to determine the phase sequence of the system to indicate in which element the current leads or lags. This can readily be found through the use of a meter developed for this purpose or, if only used occasionally by means of the varley method which is readily applied since its equipments consists only of two lamps and a reactor and is a standard method described in electrical textbooks.

The user will find the methods far simpler to use than to describe.

Mining The Ocean

FOR UNESTIMATED years, the ocean has been gathering toll from the land and has now collected chemical elements per cu. mi. estimated to be worth five billion dollars. Some mine, if you can work it. First steps are being taken to reclaim from the ocean its treasure and, of all things, the first to be largely "mined" is bromine, used in forming Ethyl gasoline. A plant of Dow Chemical Co. near Wilmington, N. C., is pumping up 220,000 gal. of the ocean per minute, giving it chemical treatment and recovering 100,000 lb. of bromine every 24 hr.

During the 2 yr. that the plant has operated, 4000 t. of bromine, worth $1,720,000 have been recovered by pumping and treating a sq. mi. of water 76 ft. deep. But there escaped back to the sea in this water a value of $75,000,000 which was not yet catchable. This includes 86 lb. of gold, 1⅓ t. of silver, 2,000,000 t. of salt, 500,000 t. of epsom salts, 100,000 t. of calcium chloride, 52,000 t. of potassium, 42,000 t. of magnesium, 120 t. of aluminum, 8 t. of copper, 125 t. of iron, large amount of strontium (used to color fireworks red) and 2¾ t. of iodine.

Treatment for bromine recovery is mixing with right proportion of sulphuric acid, then chlorinating, which frees bromine gas. This gas is blown through a spray of soda ash, reacting to form a solid called "mining salt," which in turn is used in making antiknock gasoline.

Next in order or a try at recovery is magnesium, which is used in making Dowmetal for airplane frames and motors. Plant is under construction at Freeport, Tex., which is expected to take a cu. ft. of magnesium from each 1000 cu. ft. of ocean treated, and to treat 12,000,000 gal. of water a day. At that, it will take 800 yr. to extract the 5,700,000 t. of magnesium from just one cu. mi. of ocean. That mine isn't likely to run out soon, as there are some 417,885,000 cu. mi. of water in the sea. Here's the total value of the chemical elements in the ocean, exclusive of water, at $5,000,000,000 a cu. mi. It is $2,089,425,000,000,000,000 or over two billion billion dollars.

Electric Cord Safety

TO AVOID danger from electric cords connecting portable equipment, New Jersey Public Utility Information Committee gives the following rules:

Never run cords under rugs. The covering is quickly worn when walked upon.

Do not place cords in door jambs. The protective covering is soon broken.

Keep cords away from radiators and steam pipes. Heat softens the insulation.

Disconnect heating appliances and irons when not in use. And always disconnect by taking hold of the plug, as pulling on the cord will loosen connection to the plug.

Do not use cord for permanent wiring. Replace or reinsulate worn cord promptly and inspect periodically for condition of the covering, especially the rubber insulation.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

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DO YOU LIKE SHOP TALK?

THIS NUMBER contains the second presentation of our new department, "Shop Talk". As announced in the January issue, this department will be devoted to the presentation of photographs showing devices and arrangements worked out by various engineers to facilitate operation or to make their work more convenient. So far we have only made a start but the publication of the single page of photographs in the January issue has already brought results. Several readers have sent in pictures, some of which are shown in this issue. If interest in this department proves sufficient we will expand it to include two or more pages of pictures in each issue. Taking a cue from the general magazine field we feel that engineers as a class are as susceptible to the lure of photographs as any other group and in "Shop Talk" it will be our endeavor to cater to this interest even if we cannot promise you many bathing beauties. In doing this, however, we will need your help. Send us pictures. Surely somewhere around your plant you have rigged up some little gadget of interest to someone else. Get out your camera or get some photograph enthusiast around your plant to get his and take a picture of it. We will be glad to publish it.

A. W. K.

A Section of Power Plant Engineering Devoted to PLANT OPERATION AND MAINTENANCE

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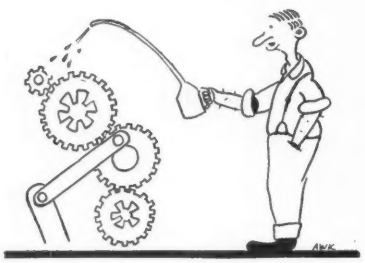
CONCERNING ORGANIZATION

Notes on the problem of properly organizing the personnel in the power plant. Although modern equipment is highly automatic, it still takes men to direct its control and unless the men who effect this direction are trained, all the advantages of modern plant design can be lost. A satisfied, yet ambitious, well trained staff is the most valuable asset a plant can have. As pointed out, this requires leadership.

IN ABRAHAM Flexner's interesting autobiography "I Remember" which was published last fall, he discloses the fact that many of our American educational institutions are overburdened with "plant." He ventures the opinion that in many instances too much money has been spent in erecting imposing buildings and gymnasiums and stadiums and perhaps even in equipping laboratories and that not enough has been spent on brains. In other words, he implies that a capable teacher with brains is of more importance in the field of education than granite buildings and shining but often useless laboratories.

Many of us who have exhibited any interest whatever in education have been aware of this fact but coming from a man like Dr. Flexner, who has accomplished so much in raising the standards of American education, it is extremely significant. Fine buildings, elaborately equipped laboratories are wonderful assets but only when an efficient staff is available to man them. Human beings, despite our technical advances, still remain the most important things in our world.

The parallel between the field of education and power development is not exact but Dr. Flexner's stress on the importance of personnel applies here as well as in all other fields of human endeavor. Modern power generation is carried out by beautiful, automatic equipment, seemingly without the aid of men; indeed a large central station is as deserted as Wall Street on a Sunday afternoon, yet the personnel, tenuous though it may be, is the really important thing in the plant. He may only be a lowly oiler or a stoker attendant, yet one improper move on his part may cause no end of confusion or destruction. He must be trained; however simple his duties, he must understand them.



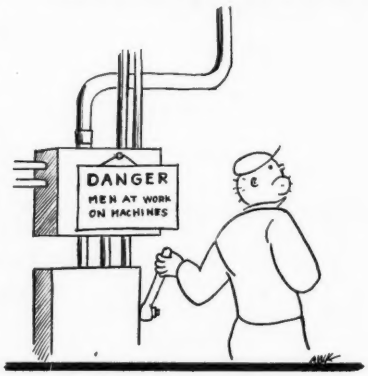
He may be only a lowly oiler

Because of this, the training of men is perhaps the thing of greatest single importance in the operation of a plant—not only the training but the continued direction of the men. A satisfied yet ambitious well co-ordinated staff of men is the greatest asset any power plant can have.

This requires leadership. Whether it be the superintendent, the chief engineer, the watch engineer or the strawboss, unless he understands the problems involved in keeping the men under him satisfied, responsive and effective, he will find, sooner or later, that something is very wrong. Often he may not be able to put his finger on it; it may exhibit itself in the failure of equipment to operate as it should, in the creation of sudden emergencies, in the loss of confidence his superiors repose in him. An organization of men is subject to diseases in much the same way that disease attacks living organisms. Organization disease manifests itself in poor morale, inefficiency, lack of co-ordination and all of them put together. Often these conditions may prevail for years and even after the person mainly responsible for them has been removed, the real nature of the malady may not be apparent to the undiscerning. Rebecca West in a recent book makes this penetrating observation, "it is the habit of people, whenever an old man mismanages his business so that it falls to pieces as soon as he dies, to say, 'Ah, So-and-so was wonderful! He kept things together so long as he was alive and look what happens now he has gone!'" What they fail to see is that such an organization had gone to pieces long before the old man's death and that it was too weak and worn to withstand the necessary reorganization.

With these things in mind it is scarcely necessary to stress the need for proper care and organization of personnel in the operation of a power plant. This phase of operation is much more important than the care and maintenance of the plant equipment because with well-trained personnel the proper maintenance of equipment follows as a matter of course.

In these pages we devote considerable space to articles dealing with the upkeep and operation of mechanical and electrical equipment. This is as it should be, that is what everybody is very much interested in. It is quite as important, however, that some attention be given this question of personnel and organization. This question is of just as much importance to you whether you are boss or subordinate; in either case it is necessary for you to understand your part in and your relation to the organization



One improper move

as a whole. Proper organization is important to you no matter what your status may be.

It is our intention in these pages to stress this need for proper organization whenever we have a good opportunity to do so. Articles on this subject will be presented from time to time and there will always be space for intelligent discussion of the subject by the readers.

In this issue we are pleased to have the opportunity of presenting the following article by Mr. Grover. Speaking in his own right as a result of long practical experience, his consideration of the subject is much to the point and the application of his sound and tolerant ideas should prove effective in any plant.

A. W. KRAMER.

How to Develop a Waiting List of Prospective Employees

By William H. Grover

THE DIFFICULTY of keeping employees and keeping them satisfied is a subject that receives considerable discussion whenever a group of chief engineers get together. Personally, I have never had trouble in keeping plenty of good men on my payroll and when that is the case there is never any trouble in filling vacancies with good men.

Skilled labor is not hard to keep when all the conditions about the power plant are right, and the men fairly treated. In making this statement I do not wish to be understood as trying to insinuate that specific conditions are right, wrong or indifferent, but rather I wish it to be understood that I know that there is a certain running balance of the personnel that must be maintained on an even keel, if good men may be expected to stay on the job. Labor is not hard to deal with, when we have the opportunity to deal with labor direct. A close analysis of one of the great strikes will prove that we are not dealing with labor, but with their selfish, unscrupulous leaders who, first, do not know the fundamentals of management, and if they did, their attitude of mind is such that they could not deal squarely.

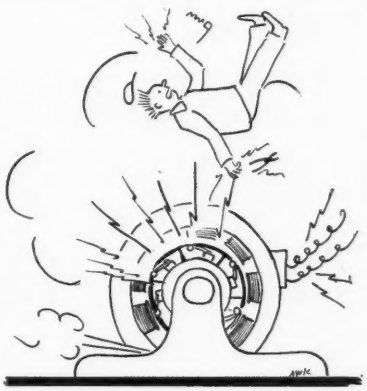
Labor itself does not ask much. First of all labor looks for a square deal, good working conditions and work. The leaders of organized labor make their case on the fact that capital has not always tempered administrative justice with mercy; then the leaders of labor have made a copy of that principle, which is wrong.

No system can survive that fails to temper the administration of justice with mercy.

There is no excuse for poor working conditions about the power plant. It costs so little to have perfect sanitation, air conditioning and anything else that will make the life of the power plant more livable. We will assume that this one necessity is cared for and that so far as working conditions are concerned the power plant man is cared for.

Livable conditions assured the next of importance about the power plant is the dispensation of justice; a square deal if you please, that's what men want; that is what they wanted when they were very small children. A boy 7 years old somehow has a good sense of justice and he always will have it.

Then, Mr. Power Plant Manager, it is up to you to build into the minds of the employees the idea that justice tempered with mercy prevails there. This admonition is not an easy one nowadays, but it must be done. For some executives it will appear amazing, because it involves the manager as well as the men. It is astonishing how the seeds of justice and mercy will grow when sown into fertile soil of labor that is first rid of the cobwebs of cheap politics and misguided leadership.



Can cause no end of confusion

With this principle established you are ready to proceed intelligently to build an organization that will perpetuate itself and be a credit to you and the financial institution it represents.

You must see to it that everyone for whom you are responsible is provided with everything needed to make his part of the work a success; school him in its operation if need be, then watch him through his work carefully and note how loyalty will come forth in his department. When you have done these things and the man does not respond, sift him. Then you will discover that you are sifting at the right end of the line. If you furnish the individual everything he needs to succeed, and teach him how to use it and he does not respond, then when he slips down and out you will not have lost a good man. A good man wants the things you put into his hands which he failed to recognize as a beginner. If you placed success in a man's lap and he proves incapable of attaining it, it will be right to sift him. Under these conditions the sifting will be found to be a small matter, if any pretense of initial selection has been exercised.

On the other hand the man that does respond will be with you for many years unless his development has been so great that he can take a much better position than the one you have to offer him. Then it becomes a pleasure for you to recommend him for the new job, knowing full well that you have been a part of his development.

Do I hear you ask "who you would put in his place?" Well, if you run your power plant on the basis I have outlined, you will have many men that can step in and take his place, and more men standing ready on the outside, the raw material, with which to develop real power plant men.

I have been in a position of responsibility a long time and I never had a real man fail me. The other kind of men represent a small percentage compared to the good ones.

With the proper kind of atmosphere and consequently the proper attitude of mind there is a lot to be learned around the power plant and if the workers are provided with means of making analyses of various kinds you will have no trouble in keeping your men over long periods of time.

You cannot buy efficiency of the men, you must build it into your plant. If you were to buy efficiency and not build it, it would not stay with you very long. It would be like gun powder, good until it got wet; then it would not fire.

Power plant men must build themselves into cost minded men; then efficiency is possible, otherwise it is worthless and does not exist. When these men work on this basis they go farther into the real details of operation than routine operation demands; they look beyond their jobs. Any man who only gets out of his job what is sent to him in his pay envelope is poorly paid indeed.

Those who have trouble in keeping good men, are liable to have trouble in getting money for extraordinary maintenance.

Positive reports such as you will be able to make, backed up with the figures are the ones which get the money for replacements. For instance: suppose you need a new pump very badly and you go to your superior and say to him, "Mr. Manager, we need a new pump. This one is old and badly worn and not reliable and has just about outlived its usefulness. It will cost about $200.00 to repair it. We need a new one." Nine chances out of ten he would say, "I know, George, we need one all right, but money is hard to get and I think that we will get along another year with the old one."

On the other hand, if you approach your superior in the following way your results will be quite different:

"Mr. Manager, I have made a study of pump No. 7. I find that it has been in service more than 20 years; that it must be rebored, have new piston rings, the valve ports must be faced and all together it will cost $200.00 to do what may be called emergency work on the pump. It is also very much antiquated. A new pump will be very much more efficient and reliable and can be purchased for a thousand dollars. The new pump, due to modern features, will handle the service, with a power cost of $500.00 less per year than the old one. Of course we can apply the repair bill of the old pump on the new investment, so that at the end of the first year, the savings on the operation of the new pump plus the repair of the old one, will leave only a balance of $300.00 on the new pump. While at the end of the second year, on that basis, the new pump will have paid for itself and $200.00 to the good. What will we do about it?" Your answer will be, "Buy the new pump."

Positive statements with definite figures to back you up are the things that get results.

But you say, I cannot get the figures with which to make the positive statements. My answer is "Get that way." I assume that *you* are cost minded but you must also develop your key men into cost minded individuals; furthermore, you must get whatever is needed to obtain the cost of every operation in the plant. In this way you are developing cost consciousness in the plant which is most valuable. You cannot purchase it, it can only be made.

If you will do these things, your men will not leave you unduly, because you have built a plant consciousness and your best men own a part of that consciousness and they will not leave it. They will like their work; they will like you and when they leave it will be because they have grown above their position in your plant, not away from it. They will be very sorry to leave and would not, except that duty calls them to do the best by themselves and their families. You will be filled with pride to recommend them for higher positions than you can furnish.

FOR THE PLANT ELECTRICIAN

Determining the Neutral Point of Generators

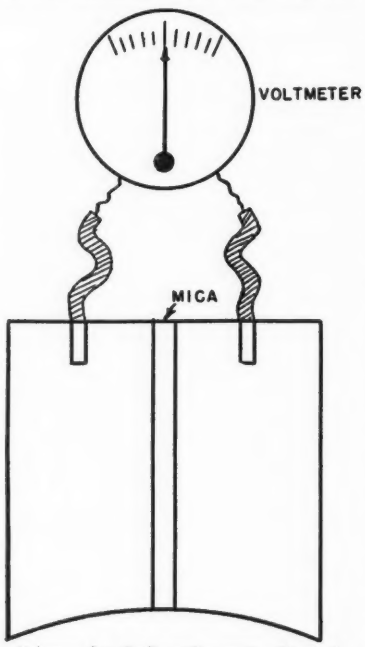
By Myron Carl

QUITE AN array of suggestions on how best to determine the exact neutral point of electrical generators have been offered through the medium of text books and periodicals, however, here is suggested a method whose simplicity of construction and ease of operation recommends it highly.

When re-brushing a unit retain two of the best stubs. These two are sawed down the middle and the two halves in which the pig tails are fastened have the saw marks dressed off with a file or sand paper. Then a sheet of mica (or any other good dielectric) is cut to fit the finished surface and securely cemented in place on the one brush half. The other half is then held temporarily against the mica and the two halves are fitted into the brushholder as a unit. Usually the material removed by the saw and the file will just about be taken up as space by the mica and cement.

Now if the improved brush fits the holder additional material must be removed from the non-cemented half to provide space for five turns of Scotch tape wrapped snugly about the two halves. Before this tape is applied, however, material is also dressed from the end surface so that tolerance is equal on all sides. If the job has been done right the device will slip easily into the brush holder as it did before being sawed. Then the pig tails (if not beaded) are insulated with tape and fastened to a voltmeter.

Then during a shut-down period when no danger of a flashover is possible the brush rigging clamping bolts are loosened, but first the old setting is chalk-marked as a reference point to note later the degree of adjustment that was accomplished. With the device in place the machine is started and loaded as usual and the brush rigging is slowly shifted forward and back with close attention paid to the voltmeter all the while. The voltmeter used should be a millivoltmeter and preferably one of the differential or zero center type.



Scheme for finding Generator Neutral

Once the exact neutral point has been determined a permanent mark is made with a chisel or punch and the job of neutralizing that particular machine will never have to be done a second time.

Precautions Against Electrical Accidents

BEFORE attempting to develop the precautions to be taken against accidents, it is essential that the basic cause of accidents be thoroughly understood. A simple analysis of several accidents will assist in developing the basic cause of accidents.

Example 1

A central office repairman moves a rolling ladder on the top rung of which a soldering iron has been placed. The iron falls, hits him, resulting in an injury. Had he known the circumstances surrounding the ladder and soldering iron he could have taken the necessary precautions to avoid the accident and the injury.

Example 2

A splicer pours heated paraffin into a damp container. An explosion occurs resulting in an injury. It is obvious that if the splicer had known the circumstances surrounding the container he could have taken the necessary precautions to avoid the accident and the injury.

Example 3

A lineman attempted to reverse his position in a cable car while riding strand in order to keep his legs from coming in contact with open wire circuits beneath the strand. He lost his balance, fell and suffered a serious back injury. Failure to recognize all the circumstances associated with riding this strand caused this man to start to ride the strand in a wrong position in the cable car and then to attempt to remedy the mistake by a wrong procedure.

Example 4

A repairman planned to reroute a drop wire that was the only attachment on an old pole. He recognized the pole as being unsafe to climb and decided to work from a ladder placed against the pole. He removed the drop wire, the pole broke and he fell, suffering a serious leg injury. If this repairman had observed all the circumstances surrounding the removal of the drop wire from this pole, he could have taken the necessary precautions to avoid the accident and the injury.

This method of simple analysis as applied to these examples can be applied to every accident and will result in a broad conclusion that if an individual knows all the circumstances surrounding the action that he is about to perform he can take any one of several precautions to avoid an accident.

An accident occurs when a man does something that conflicts with the circumstances as they exist at a particular moment. The action which he performs may be a simple every day action yet when performed at a particular moment so that it conflicts with the circumstances

as they exist at that same moment it will result in an accident.

The simplest action when performed at a particular moment will result in an accident. Doing what is usually the right thing at the wrong time will result in an accident. In the examples cited, all were essentially simple actions performed many times by these employees resulting in accidents because they happened to conflict with circumstances at the particular moment when they were performed. They furnish good examples of doing what are normally simple operations under the wrong circumstances.

When accidents are viewed in this light, a new conception of the meaning of hazards is obtained. If all the circumstances surrounding a particular job are known, a procedure can be planned to do the work in an accident-free manner. An accident-free plan of doing a job has no hazards. Therefore, hazards exist only when the plans to do the work are inadequate. In other words, a man introduces his own hazards into his work by not recognizing all the circumstances involved and basing his plans on this recognition.

How an Accident Is Developed

In summary, an accident is developed as follows:

a. A man fails to observe the circumstances present at the time he is about to perform some action.
b. Failure to observe these circumstances immediately introduces a hazard into his work.
c. He attempts to perform the action that conflicts with the circumstances.
d. He has an accident.

Accidents are prevented by recognizing all the circumstances present and planning the next step on this recognition. Accident prevention training compels a man to recognize that an accident can occur any time, any place, if he fails to be guided by circumstances.

Consider the circumstances that may surround the climbing of a pole. The pole may be spur cut; it may be ice covered; it may be rotted below the ground line; it may not be supported by a strand; it may be subject to a side strain; if it is a terminal pole, wasps may have built their nests in the terminal. All these circumstances must be recognized even by the most expert climber before he can be assured of not having an accident. It is when he performs the simple job of climbing, ignoring any of these existing circumstances that he introduces the hazard that causes an accident. Training a man to climb a pole is training him to observe all the circumstances surrounding the climbing of that pole.

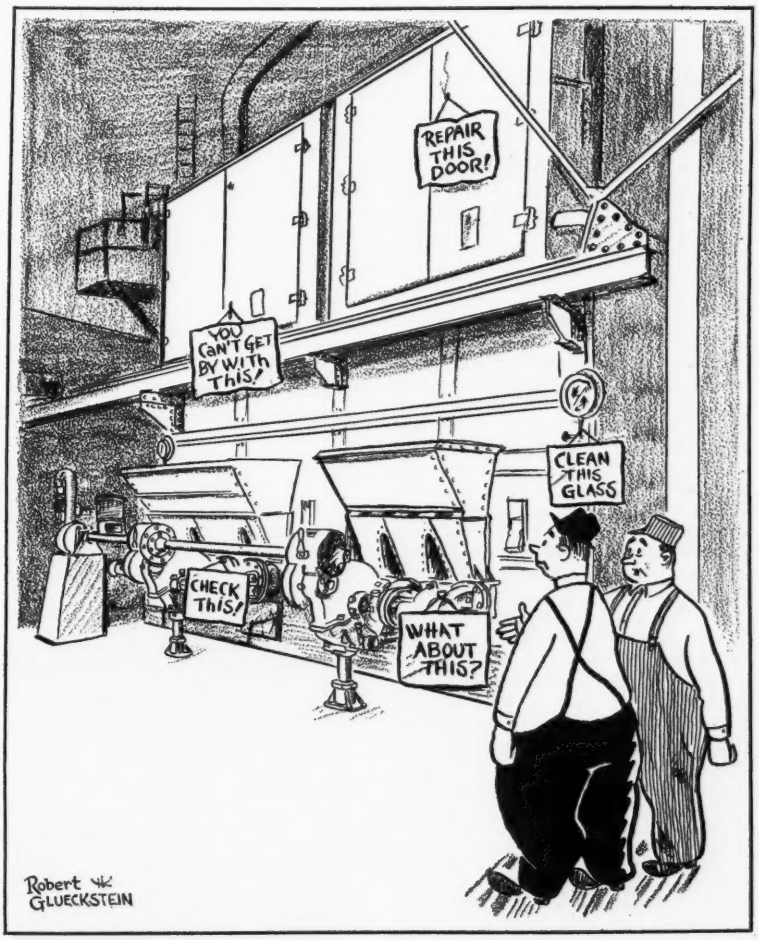
Consider the circumstances that may surround work on a suspension strand. Is the strand of sufficient strength; is it deteriorated; is it securely anchored at poles or buildings; are the poles or buildings to which it is attached able to withstand the additional strain; should the proposed work be performed from a ladder or from a strand chair; is there sufficient clearance from adjacent power wires and telephone wires; are all the factors surrounding the circumstances specifically known as the result of personal investigation or is reliance being placed on what somebody else has stated to be a fact. A craftsman introduces a hazard into his work when he proceeds to work on a suspension strand without a knowledge of all the circumstances involved. Training a man to work on a suspension strand essentially is training a man to observe all circumstances prior to and during his work on the strand.

Training for Accident Possibilities

One of the best methods of training a man to observe circumstances for accident possibilities is by continuous illustration on the job of the fact that on countless occasions the ability of the individual to foresee circumstances is the reason why he avoids accidents. If the supervisors will devote a definite period of time to periodically observe craftsmen at work, they can draw the craftsman's attention to all the hazards he may introduce if he does not continually look one step ahead of every act. Some of the principal reasons for failure to observe or to be guided by observed circumstances are:

a. Personal characteristics or irresponsibility; recklessness; willingness to take a chance; lack of ability to see ahead; ill health; financial or domestic worries; inadequate rest or recreation.
b. The example given by other employees, both craft and supervisory, resulting in the thought that "if other people can take a chance so can I."
c. Undue pressure either by fellow craftsmen or supervisors to complete a job in less time than that necessary for safety.
d. Improper or inadequate training methods. The object of training methods is to get the wholehearted co-operation of an individual not his grudging obedience.
e. Improper or inadequate supervision which fails to recognize that accident prevention is on a par with quality and quantity of production and that the requisite quality and quantity of production cannot be obtained except with an accident-free procedure.

—Excerpts from Educational Program for First Line Supervisors, Health and Safety, Southwestern Bell Tel. Co.



"The Boss has such a subtle way of giving orders around here!"

Questions And Answers

95

What Corrodes Most, Hot or Cold Water?

Q. We are about to install new water lines in our laundry. We use 90,000 cubic feet of water weekly, 60 per cent of this is hot water at a temperature of 180 deg. F., 40 per cent cold water at 45 deg. F.

We wish to install one copper pipe line and one galvanized pipe line. The question has arisen as to which line corrodes galvanized pipe most, the hot or the cold water. Comments from other readers will be appreciated.

New York, N. Y. H. J. MOORE

96

Trouble With Manhole Plates

Q. We have two H.R.T. boilers in our plant, 72 in. by 14 ft. with 11 in. by 15 in. manholes. Several years ago our lower manhole plates began to leak so we checked the holes in the boilers and the plates. The manholes seemed to be correct but the plates were off.

So we sent to the manufacturer of the boilers for one new plate. When it arrived we tried it but with no satisfaction. The more we tightened it, the worse it got. So we took the old plates down (these were of the solid bolt type) to the machine shop to have them trued up. While they found the high spots they did not get them true and charged us the price of new plates. So we sent to a large valve manufacturing concern for new plates and they sent our order to the manufacturer of our boilers. Soon two more plates came and these were not better than the first ones. It seemed that the die had not stamped them out correctly.

We sent these plates back to the boiler manufacturer who reported that they had never had trouble of this kind before and could give no reason why the plates should not be OK. However, they put them in a lathe which was supposed to true them up and they charged us for doing this.

When we received these plates the trouble had still not been corrected. With a heavy gasket and drawn up just snug, they hold from four to five weeks but then start to leak again. If they are drawn down tightly they start to leak at once and the tighter they are drawn the worse the trouble becomes. So you can readily appreciate the fact that we are very much disgruntled and would like to know how we can remedy this trouble or where we might buy manhole plates that will prove serviceable. We would like to get plates of the loose bolt type.

If any other reader of this magazine can offer any suggestions or tell me where to buy these manhole plates I will be very grateful.

D. H. W.

97

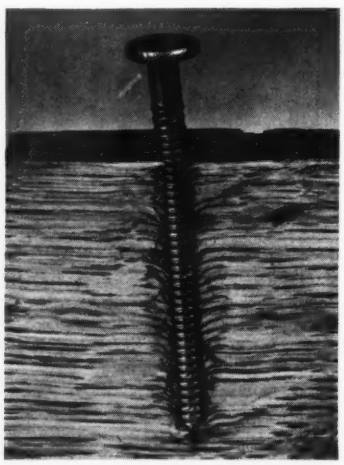
Pulling Nails

Q. CAN you give me any information on the relative holding power of nails as compared to wood screws?

Bound Brook, N. J. J. E. C. V.

A. THE holding power of nails and screws is dependent upon a number of factors, and varies considerably with different conditions. Wood screws on the average have something less than twice the holding power of nails of the same length and diameter but, of course, the character and condition of the wood into which the nails and screws are driven affect the relative holding power.

Of interest, in this connection, are the results of a series of tests made recently by the Independent Nail and Packing Co., Bridgewater, Mass., makers of the "Anchorfast" Monel metal nail. The latter is a special, rust-proof nail having a series of sharp annular grooves rolled on during manufacture. As shown by the accompanying illustration these grooves are sharp and are set at such an angle that in driving they do not disrupt the fibres of the wood, but grip with great effectiveness when a force is applied in the reverse direction.



In testing the holding power of these nails the following results were obtained. They are of interest not only because they show the great holding power of this special nail but also because they show the relative holding power of nails as compared to a woodscrew.

(1) "Anchorfast" Monel nail, 2 inches long, 840 pounds.

(2) No. 8 woodscrew 2 inches long in a 3/32 inch pilot hole, 816 pounds.

(3) Galvanized cut nail, unclinched, 510 pounds.

(4) Galvanized wire nail, unclinched, 552 pounds.

(5) Copper nail, riveted, 2½ inches long, 708 pounds.

(6) Galvanized wire nail, clinched, 642 pounds.

The above are average results as determined by a series of 20 comparative tests. All fastenings were driven into the wood within 21/32 of an inch from the head.

98

What Happens When the Condensate Pump Stops

Q. 1.—We have installed a 500 kw. "condensing type turbine" with a condenser and surface type steam jet air pump and a motor driven condensate pump. A question has come up as to what would happen if the condensate pump should stop for some reason (blown fuse or hot bearing). I claim that the condenser would fill with condensate to the ejector inlet pipe; the ejector would not work and condenser would fill with air and the vacuum would break; and the turbine would run non-condensing even though the cooling water was flowing through the condenser. Am I right?

I have been told that the condenser would fill with water to the turbine and it would tear out the last row of blading. I cannot see it that way as the atmosphere exhaust pipe is 2½ feet below the turbine, with a one inch drain. This should take care of the water if the condenser should fill with water.

2.—I also claim we could run this turbine non-condensing even though the cooling water pump stopped; the condenser discharge pipe is about two-thirds the height of the condenser which leaves two-thirds of the condenser tubes surrounded with water at all times.

I have been told that if the pump stopped the exhaust steam would over heat the condenser and cause the tubes to leak. Which is right?

Springfield, Minn. H. B. K.

A. 86

SOS From Philippines Answered. Help on Way

IN ANSWER to S.O.S. from the Philippines in your January 1941 issue:

Install a current transformer in the neutral resistor circuit. In the secondary, connect a CO relay or instantaneous relay set slightly below safe carrying capacity of resistor. The relay could either give an alarm or trip the neutral breaker.

It would seem to me that ground relays either low energy CO or CR should be provided for the 13.2 KV ties and feeders. This would provide fast clearing of ground faults. On our system (West Penn Power Co., Pittsburgh, Pa.) the 25 KV system is grounded through several resistors scattered over the system. We use low energy CO and CR relays on all ties and feeders and a signal and recording ammeter on all resistors. So far as I know we have never burnt up a resistor.

At one power plant, a current transformer in the neutral resistor circuit connected to a thermal relay (General Electric Co. type TC 211A10) closes a breaker to short out the resistor. This, of course, increases the fault current and should cause the phase relays to operate.

Pittsburgh, Pa.

HARRELL DENMEAD,
System Operating Engineer,
West Penn Power Co.

99

How Can You Give Switchboards an Oil Finish?

Q. COMMERCIAL switchboards are frequently specified to have an oil finish. In building small switchboard panels for use around the plant we have tried to obtain this finish without a great deal of success. We have tried several grades of oil but so far have not obtained the desired results. The oil we used seemed to soak up or be absorbed unevenly in the slate leaving dull spots over the panels. Can you advise me what preparation the manufacturers of switchboards use and what procedure is used in applying it?

Grand Rapids, Mich. C. STITH.

A. 83

Air in Hot Water Radiators to P.S.R.'s Question

I WOULD not advise P.S.R. to put oil in the expansion tank of his hot water heating system as I do not believe it would clear up his trouble but only cause him more trouble in the future.

As a general rule, hot water systems are drained only when necessary to make repairs and it would be very easy to forget all about that oil in the expansion tank several years from now when the system is drained for repairs. Then he would have to go through the extra expense and trouble of cleaning the oil out of the system.

There is a possible chance that his trouble is due to improper adjustment of the pressure regulator, assuming it is a pressure system with the expansion tank in the cellar as he states in his problem. I know of several instances where the static head was greater than the pressure that the regulator was set for and the radiators would not completely fill with water, thereby giving the impression that the radiators were air bound.

I have found that the best way to correct this is to let the fire in the boiler go out and the water in the system cool down to normal temperature. When the system has cooled off, open the air valve or break the connection on the highest radiator and let water run into the system until water starts running out of this radiator. Then shut the water off and purge the air out of all the radiators, then check the highest radiator again to make sure that it is full; if not, let more water into the system until it is full. After doing this note the pressure on the gage on the boiler and adjust the pressure regulator to carry the pressure about 3 or 4 lb. higher than the static head when the water is cold.

There should be very little transfer of air from his expansion tank to the radiators if it is installed properly. While all the recent hook-ups I have seen show the expansion tank tied into the hot water riser through a non-reversing flow valve, some prefer to connect it to the return line by the boiler.

There should be hot water air valves on all the radiators and these should be checked about once a month during the heating season to insure good results.

DONALD OSTERHOUDT
Poughkeepsie, N. Y.

A. 83

CUSTER'S STAND

IN REGARD to the correspondent, P.S.R., who asks about air in radiators of hot water heating systems, I do not advise the use of oil as a seal in his expansion tank as there ought to be a better way to regulate this.

If his system of piping is built right he ought to have no trouble of this sort. In hot water heating it is important to have a boiler plenty large for the service so it needs not to be forced; also there should be plenty of radiation to fit the capacity of the boiler so that the house will heat in zero weather with a temperature of the water never higher than 180 deg. A system operates best when the static head of the water at the boiler is 15 lb. or higher. With a two story house and the expansion tank located in the garret with an overflow to the roof we get a pressure at the boiler of about

100

WHO HAS A MOTOR REPAIR SHOP?

We are thinking of establishing a small motor repair shop to maintain and repair the motors in our plant, that is, both the power plant and the factory. Not having had much experience in motor repair work I would appreciate advice from others who may have such shops as to what equipment and what supplies will be needed. The shop will handle direct current motors up to 500 v. and up to 20 hp. capacity and alternating current motors of 220, 440 and 2200 v. up to 150 hp.

What I should like to know in particular are the following. 1. The most generally used sizes and types of magnet wire. 2. The most generally used kinds and thicknesses of insulation. 3. The most useful thicknesses of commutator mica segments and flexible mica for commutator V-rings. 4. What are the minimum requirements concerning, machines, i.e., lathes, winding equipment, soldering and brazing and 5. Is welding equipment necessary.

I would like to have comments from others who have operated such repair shops.

Toledo, O. V. P.

15 lb. which operates very nicely. However, with a cottage of only one story there is insufficient head and recourse is had to a closed system with a closed expansion tank with an air cushion. This kind of a system is often hooked up to the local water service with a reducing valve from the water service and a relief valve to operate say at about 15 lb.

The trouble with a one story job with merely an open expansion tank often occurs when someone builds too big a fire in the boiler and boils the system over, thus reducing the water in the system. Or if it is an auto-filling system and the reducing valve fails to function it may lower the water so that some of the air from the cushion in the basement expansion tank gets out into the heating mains and into the radiators and puts them out of action. Then the temperatures run up and we have known of cases where they have blown all the water out of the boiler and burned the boiler.

We would recommend to P.S.R. that if it is possible to move his expansion tank to the garret from the cellar (the piping needs to be only small) there will be less likelihood of getting air back into his radiators. The auto-fill reducing valve from local water system should be tested from time to time to see if it functions properly. The auto-relief reducing valve should not be discharged direct into the sewer but should discharge onto the cellar floor where it will be immediately noticed if it gets to leaking or otherwise fails to function. I assume that P.S.R.'s system is equipped with reducing and relief valves of the Mueller or Thrush type.

In a common two story job properly constructed with open expansion tank located in the attic after the system is started in the fall and all air is out of the radiators it is unlikely that any more air will have to be let out the rest of the season. Also water in small amounts need be added to the system only once or twice during the season.

There is a system of hot water piping possible by which attic supply pipe is run around the attic and return mains only in the cellar and all radiators connected to down pipes by which the air in system will always drain upward to expansion tank in attic which makes it unnecessary to have air valves on the radiators.

In locating expansion tanks in cold attics where there is danger of freezing, the expansion tank may be equipped with a return pipe back to the cellar mains so that it will circulate like a radiator. A handy way to tell if the attic tank has enough water in it is to feel the supply and return pipes in the basement that go up to said tank and as long as the one is hotter than the other, we know the tank is functioning with enough water.

C. C. CUSTER

Logansport, Indiana

A. 85

Pump Constant? No, But Lots of Answers

We are glad to announce that the "pump constant" question submitted by H. F. and presented in the December issue resulted in excellent response. Many replies were received and while most of them do not recommend the use of an empirical constant as was suggested, the comments on the problem should be of value to H. F. Some of the replies are presented here—others will appear in a subsequent issue. Editor.

IT IS impossible to establish an empirical constant for H. F.'s water evaporation until the feedwater temperature is known since the weight of water varies with the temperature as shown below.

Temp. deg. F.	Relative Volume	Weight lb. per cu. ft.
39.1	1.0000	62.425
100.0	1.00706	61.99
150.0	1.020	61.20
200.0	1.038	60.14
210.0	1.042	59.91

Assume, for example, the feedwater is at 200 deg. F. The volume of water pumped per revolution of the pump is

$$\frac{.7854 \times D^2 \times L \times (1.00 - S)}{1728} \times 2$$

where D = diameter water cylinder in inches
L = length of stroke in inches
S = Slippage of pump due to wear in decimal fractions

then Volume =

$$\frac{.7854 \times 30.25 \times 10 \times (1.00 - .27)}{1728} \times 2$$

= .2007 cu. ft.

the weight = .2007 × 60.14 = 12.07 lb. per revolution the total weight = number revolutions times 12.07 (the constant at 200 deg. F. feedwater). Using any other feedwater temperature a different constant would be obtained.

It appears that H. F. is working with too many assumptions, any or all of which may be wrong. An evaporation of 9.6 lb. water per lb. coal in 1935 does not assure the same evaporation today or even the day following the test run. Pump slippage likewise is a variable changing with usage. Thus he has no reliable data upon which to calculate either steam output or coal consumption.

A plant burning 11 tons coal per day or approximately 3300 tons per working day year at perhaps $5.00 per ton or $16,500 per year for fuel merits the outlay of 10 per cent of the yearly fuel bill for purchase of equipment to show the firing personnel what they are doing. For $1650.00 H. F. can purchase a reliable steam flow meter, a platform weigh scale, a recording flue gas thermometer, a furnace draft gage and an Orsat for flue gas analysis. Such equipment would give fairly complete operating data upon which to seek improvement and the improved efficiency—attained with these eyes to guide the fireman will result in coal savings that should easily repay the cost of equipment in one year or less.

R. S. JULSRUD,
Harmon-On-Hudson, N. Y.

IN THE December number of POWER PLANT ENGINEERING, Mr. H. F. calls for help on one of his problems. Mr. H. F. wishes to have a better empirical constant for his steam pump which he uses as a "water meter". He says that his purpose is to find out how much coal he is using, basing his method on a test that was made in 1935. It appears that in 1935 some engineering concern made a test and found that he was producing 9.6 pounds of steam with each pound of coal.

If, H. F., your test extended over a period of a week or more it might have some value, if you used the same coal out of the same seam in the same mine, with the same proximate analysis in some cases might be the same.

You say you have a duplex steam pump making an average of 60 strokes per minute. Then you refer to the number of counts the counter makes; however, I will assume that the count is 60 strokes per minute. The revolutions or cycles per minute would be 4 times 60 equal 240 strokes per minute. I, of course, am assuming that the duplex pump is a double acting pump because the most of them are.

The pump is a 7½x5½x10-in. That is, the water end is 5.5 in. in diameter and the stroke is 10 in.

To get at the constant—first we are interested in the piston displacement of the pump which is the area of the piston times the stroke.

The area of the piston is 5.5 in. squared times .7854 = 23.7583 sq. in., then times 10 in. to get the cubic displacement of the piston which is 237.583 cu. in.

We will assume that the temperature of the feedwater is such that the weight of 1 gallon of feedwater will be 8.3 lb. with 237.583 cu. in. then we would have as many gallons as 231 is contained in 237.583 cu. in. or 1.024 gal. Then if one gallon weighs 8.3 lb. the piston displacement would be as many pounds as the product of 8.3 and 1.024 = 8.499 lb. or say 8½ lb. Now we know that every time the piston makes a stroke, 8½ lb. of water is pumped. The pump strokes are indicated by the counter but it being a duplex pump and double acting, there are two strokes for each count of the single pump and there being two pumps, so far as the counter is concerned, each time it registers 4 × 8.5 = 34.0 lb. of water have been pumped.

If the total number of counts in 24 hours or one full day is the difference between 35,687 — 22,850 = 12,837 counts, then the total amount of displacement would be 12,837 × 34 = 436,458 lb. Now if the pump is in very good condition and taking full stroke, that is the amount of water that would be pumped, but on

PIN MONEY

Heaven only knows what engineers would do with pin money —they never dress up and they never go anywhere. About all they do is to spend their time tightening loose nuts around the plant and sitting around in various odd corners waiting for something to happen. If nothing happens, theirs is sure the life o' Riley. But they don't need pin money. However, most of them can use a few extra "bucks" occasionally—I never yet came across anybody that couldn't—and so, once again, I take this opportunity to point out that they can make a little extra cash by simply expressing their opinion about some of the problems presented on these pages. We pay for all answers published. Even a short letter is worth a dollar or two. Your idea may be of value to others and the cash certainly can be of use to you. Take that screwball, Pulverizer Pete for example. If ever there was a loose nut around a plant he is it, yet he makes a fat living writing cockeyed nonsense about things he knows nothing of in the first place. You don't have to write the kind of tripe he does but no doubt you have ideas about many of the problems other readers present and a short letter from you may be of real help to someone who lacks the experience you have. Just read the answers regarding the pump constant on these pages; this will show you what I mean.—Editor.

the other hand, if the pump is in poor condition and not taking full strokes the actual amount of water delivered to the boilers would be less than the counters would make. To calculate the percentage of slip or loss it is necessary to turn the discharge of the pump into a tank that could be accurately weighed or measured then subtract the amount in the tank that is accurately measured from the amount of pounds counted by the pump counters. Then by dividing this difference by the amount of the pump count we would have the percentage of slip. In your case, your percentage of slip is 27 per cent. That is, you reduce the amount in pounds the pump has displaced by 27 per cent and you have the exact amount of water delivered to the boiler in pounds.

When a pump is used for a water meter it should be calibrated at least every month in order to be sure of its accuracy. When calibrating the pump the average temperature of the feedwater should be observed. The pump is a volumetric meter, therefore the average temperature of the feedwater should be used when converting the gallons of water to pounds because when the feedwater runs hotter the water will not weigh so much per gallon. Water cold goes at 8.33 while feedwater at 210 will bring the weight per gallon down to about 8.19 lb.

In your case we have seen that every count of the pump counter is 4 displacements of water in the pump cylinder, and the displacement of one cylinder is 8.5 lb. so each revolution or cycle of the pump is 34 lb. This is exact and cannot change; it is really the constant of the pump. The per cent of slip deduced by test may change from time to time so the discharge of the pump may fluctuate.

However, my friend, you and the plant engineer are both losing a good bet when you go to all of that trouble to know how many pounds of coal you may burn in a month.

It is a crude way of making a record that does not mean a thing.

Coal has now become so expensive that it is a big item of expense and in most cases runs into thousands of dollars every year. Therefore coal in your boiler plant should be given more consideration. It should be weighed or measured accurately and the feedwater should be accurately measured. Each day the total feedwater should be set against the total coal, showing each day, and each shift if you please, how many pounds of steam is evaporated with each pound of coal. Tests such as you speak of are of but little value because the conditions vary so much that any one short test does not get accurately close to average conditions. The writer has had charge of steam plants for 40 yr. and has never operated where he did not know how much each pound of coal evaporated each day.

I have built efficiency into many plants and scarcely ever have made improvements in efficiency as little as 20 per cent. In order to do this you must become cost minded of the things that go in the expense of producing steam. You should calculate your coal weights, and your steam produced for each shift. Then the final figure should show how many pounds of steam has been produced with each pound of coal. Each fireman should do this in order to know just how his day's work compares with previous one. If you do an exceptional job of firing, the whole episode will be fresh in your memory and you can do it again and even improve upon the former day, and in that way you build efficiency in your plant. The firemen like this way because they understand just what they are doing. I usually find plants making about seven pounds of steam per pound of coal on the old time way, hit or miss way of running a business, but not long will it be before the efficiency will commence to crawl up so that the record every day or every month will be a figure such as you quote. 9.6 lb. of steam per lb. of coal.

It is well for you and the plant engineer to know that efficiency and good results can not be purchased at the supply house. It means patient study on your part. I have never known men who have started to weigh their fuel and water that reach maximum results much inside of three years. The first 6 mo. will show many fine days of results, but there will be many poor ones because you will not have mastered all of the different conditions that you will discover when you start to study actual conditions from the standpoint of actual facts. You will find that many of the old suppositions you had carried around with you so long will not hold water, so to speak, when you look at them on a basis of actual results.

You should weigh your coal as you burn it in order to be able to successfully buy your coal. If you weigh the coal and water every day, you will soon accumulate a store of knowledge about the coal that will save the firm thousands of dollars on the coal purchase.

If you have a contract with a certain firm for coal, you should be able to know whether you are getting what you bargained for or if it is more or less. To do this, your new production system will stand you in good stead. You need only to gather samples and have the coal analyzed about once per month. To do this, you should prepare two samples, one for immediate use and one to put in storage, that may be analyzed later should any trouble arise with your adjustments with the coal company. When it becomes known that you are weighing and analyzing your fuel there will be no shenanigans going on, but if you do not look after those things in a businesslike way, you or your firm will never know. With your records in hand you will have opportunity to select just the type of coal that will do the very best in your plant, which means a saving of many thousands of dollars to the plant's record and stockholders.

In conclusion, take my advise and do not bungle up your records just to get by with a phony report, but make them substantial and real and more than that to some good purpose, that will not only protect you but help somebody else.

Perrysberg, O. WILLIAM GROVER.

LETTERS AND COMMENTS

Old Man Fuse Goes to Town[1]

Dear Mr. Kramer:

Thanks for your kindness and interest in trying to locate an old-style link fuse for me through a notice in your magazine.

It is the only chance that I seem to have of getting one. I will answer all replies and will let you know what results I get.

Since the story of the fuses was published in your magazine[2], and a small article in a Hobby Section of a New York newspaper—things have been happening.

An engineer connected with a utility company called. He said that he was more than surprised to learn that such a collection existed but there was an old-type link fuse that should be added to the collection and told me to write to Charles Edison. Well, I did, and Mr. Edison had his research man at Orange, N. J., see if he had such a fuse.

I got a letter from Orange, stating that they had just two of these old link fuses but could never part with them as both fuses were attached to an old piece of electrical machinery that they use for exhibition purposes. However they said if they came across another one they'd mail it to me for the collection.

The National Hobby Museum, New York London Terrace Building, New York City, are interested in a loan of the "Fused Man."

The General Electric Co. sent me the fuse that they used in the House Of Magic at the World's Fair to add to the collection. The first floating plate.

The Consolidated Edison Co., mailed me a fuse used in the City of Lights to add to the collection.

The World's Fair Engineer sent me the fuse used for the Trylon lighting. Boy, what a fuse!

An engineer working for a wrecking company in San Francisco, sent me a fuse used in the California Exposition on Treasure Island for the fire alarm system.

A California newspaper must have copied the small Hobby Article in a New York paper as a man from there wrote saying that he would send me the old fuse from the San Francisco Ferry House, as they expect to demolish it soon on account of the bridge.

Well, Mr. Kramer, if I have any luck in getting one of those old-type missing-link fuses I sure will let you know.

When I have all the fuses rearranged I will have new pictures taken and send you one with the complete data.

GEORGE E. HAWKINS

[1]Since the above letter was written by Mr. Hawkins the request for the missing link in the January issue has done its work. Mr. Hawkins not only received one missing link but two and a lot of other fuses. Further data on the fused man will be presented in a subsequent issue.

[2]He Collects Fuses. Page 55, November 1940 issue.

It Pays to Listen, Pro and Con

WITH reference to G. L. Radamaker's "It Pays to Listen" (December issue, 1940, page 87), my feeling is that it is very untimely. It seems to me Mr. Radamaker is comparing today's youth with the one of yesteryear. It can't be done. Not so many years ago all the engineer virtually had to take care of was a simple Scotch or an H. R. T. boiler, a Corliss engine, and a duplex feed pump, and, of course, several tons of buckwheat, or what have you? Today, a lowly apprentice in a short time can be shown how to operate a CO_2 meter, forced draft hook-ups, stokers, electric feed pumps with plenty of relays, and other intricate equipment essential to properly maintain high efficiency. Armed with this broad knowledge the future chief engineer will naturally walk with a bit of "airs" about him. (Who doesn't?) He is proud of himself.

The young man of today is more venturesome. Whenever he runs up against a snag he thinks nothing of ripping a piece of machinery apart to see what is wrong. Using logical reasoning, he usually slaps it together again and gets it going properly.

On the other hand, take the Old-Timer. In his day (with a bit of exaggeration) all he had to worry about was plenty of packing for that aforementioned duplex, a good supply of buckwheat, and a few liners for that trusty old Corliss. Whenever the boiler went on a rampage the O. T. would knock in the manhole plates and give her an old-fashioned cleaning. Need I mention the chipping hammer? Today the young man will use technique. He will make use of his brains instead of his brawn. With a slight knowledge of chemistry, and a good boiler compound it's a matter of applying both to an erratic boiler. The trouble with the vast majority of "Seasoned Engineers" is that they are too proud at times to humble themselves. Whether they are right or wrong, they insist they are right by virtue of the 20th or 30th issue of their ticket.

It's not a matter of the amount of time you spend in the engineering field, it's what you learn during that time. Obviously, during the course of about twenty years the O. T. picks up a few good tricks in the engineering business. But isn't the young fireman or oiler doing the same? Even more so, because he has more paraphernalia to tinker with.

Nowadays, young engineering aspirants are well informed through power magazines, free bulletins, and the like. They have plenty "on the ball," and don't care who they tell it to. Naturally they run up against some of these engineers who will tell them, "Listen, grease monkey, you have a lot to learn. Who is running this outfit, you or I?" That, of course, puts the damper on the "young squirt" and the joint runs the way the "Big Heap Chief" says so even though his attention needs to be called to some defective condition.

Occasionally, one comes across young men of Mr. Radamaker's description. However, you cannot put them all in the same category. There are plenty of crafty young men about town that will prove their worth if only given a chance. In many instances apprentice boys are hindered a great deal through jealousy and selfishness. An operating engineer is sometimes afraid the young man will some day take his job, or through pride does not give the young man an opportunity for fear of being shown up.

There are too many men masquerading as engineers. Some have acquired the title of engineer by bluffing in towns having no license laws; others, although licensed, have gotten their ticket through fraud or when they were easy to get. Permit me to cite a case of one of these phonies. This is some of the knowledge he has imparted to me. "Light color greases are best to use because they do not dirty your hands." "A cylinder gets an admission of steam on the return stroke, so that the piston will not knock off the head." "To find out if an enclosed crank pin is running hot, feel the guard." Space does not permit me to state more of these "pippers." It does not take a young apprentice to show that fellow up; any layman can do it. It is because of bluffers of that sort that the writer is a strong advocate of rigid license laws, and until uniform and nation-wide laws

come into effect, "they'll still be going up." (Boilers.) Speaking of license laws is to wander away from the subject. However, I find it very important to mention because that is a very good method to weed out the "goldbricks." I'm sure the issue has been covered broadly enough to convince Mr. Radamaker and many others that it also "Pays to listen to a young man."

In conclusion, for the benefit of Mr. Radamaker, the author of the above is a young man who found that potato peels are also good for making good hard "likker."

MATTHEW W. PAWLOWSKI
Philadelphia, Pa.

ON PAGE 87 of your December issue, there is a communication from G. L. Radamaker complaining of the failure of young engineers to listen. Personally, I am more concerned about the failure of some of us old engineers to listen; the youngsters will probably get over it but I am not so sure about ourselves.

There is one thing that we should always remember, and that is, that the practical operating man is generally quite able to describe his personal experiences correctly, even though he may not be able to correctly explain their cause, and it is a great mistake for presumably well educated engineers to belittle such information, just because it comes from someone who is apparently somewhat deficient in technical knowledge, it is up to the professional man to do the explaining, and he should welcome an opportunity to meet the challenge.

Even an apparently absurd opinion as to the cause may not be entirely without value, if we will only ask ourselves, what is there about this experience that makes our friend think that it is due to such a cause?: perhaps he is only guessing, or trying to show off; on the other hand, he may not be, and on the basis of his own limited knowledge, his explanation may be reasonable; after all, being a good engineer is often very much like being a good detective, and we cannot afford to miss any clues.

Upon several occasions I have been told that steam syphons out of a boiler, and once or twice I have been told why. This affords an important clue, even if steam cannot syphon out of a boiler; when I have discovered just why the operating man thinks that it does, I have, in most cases got my problem solved but the thing for me to remember is that it is my business rather than his to come across with the explanation.

JAMES O. G. GIBBONS
Bloomfield, N. J.

A Pome by the Stooge

Deary Eddy:

You maybe remember that a short time back I sent you two ($2) bucks for a brand new 1941 model subscription to POWER PLANT ENGINEERING. I know its cheaper to get two years for three ($3) bucks, but the baby only had $2.19 in the piggy bank so you see I was just able to make one year. Well, as I was saying, I was all set to enjoy a whole year of P. P. E. when I see that this fellow A. W. Kramer is going to be editor of your Practical Engineer section for all next year. Immediately I want you should cancel my subscription.

However, in order to show there ain't no hard feelings, I have wrote a limerick, which is a kind of a pome and not to be confused with a lime ricky which is something different.

The Editor of P. E. and E.
A 'lectrical wizard is he.
Some day he'll be jolt
By 5,000 volt,
And the guy what pulls the switch'll be me.

I showed above pome to my boss who said I'd have to get a poet's license to write it, and besides my meter was bad. I told him kinda polite like that he had nits in his noggin, account of because the meters in our plant is as good as you'll find anywheres. He laughed and said he didn't mean that kind of meter, but one like a iambic hexameter. I let that one pass, but I did ask a friend of mine what took a corresponding course on how to be a lawyer, and he said that they can't put you in jail for writing pomes without a poet's license, so am sending you same with kindest regards.

Respectively yourn,
PULVERIZER PETE'S EX-STOOGE.

Smoke Abatement

I HAVE read J. G. Mingle's article on "Smoke Abatement,"[1] and I have considered carefully what he has to say. I am afraid that I cannot agree with him in what he says about many things with regard to "smoke stacks," as he calls them, and their relations with smoke abatement.

Mr. Mingle says that the majority of the smoke stacks are smoking because the dimensions of the stacks have been selected from tables that were not reliable, that they were either too short or too small in diameter or otherwise out of proportion. That these tables have been made up on the basis of boiler horsepower which he says is all wrong.

First, I wish to say that some tables may be as loosely compiled as he says, and if they are, the tables that are as unreliable as he says, should be exposed to the engineering public at once. In 1885, William Kent read a report before the American Society of Mechanical Engineers in which he explained his formula for chimneys, upon which his tables for smoke stacks were based. I can't vouch for other tables, but I can say that I have used Mr. Kent's table for 40 years and have checked stacks without number and I never have found him wrong. For Mr. Mingle's information, Kent's formula is indirectly based on gas velocity, varying with the square root of the height of the stack and the retardation of the ascending gases by friction within the stack. It is an empirical formula it is true, but it has proven accurate enough for practical purposes, and it involves every variable element. On the other hand, when a stack is based on boiler horsepower, it is based indirectly in proportion to stack gas velocity anyway.

Let us get a few things clear. We are all agreed why draft is created in a stack. It is because the column of hot gases in the stack are not as heavy as an equal column of cool air on the outside of the stack. Then if this be true, the static difference between the outside and inside would register the greatest when no gases are moving. For convenience, this differential pressure is measured in inches of water. Then, if we open something anywhere near the bottom of the gas tract, since the cool air is the heavier it will rush into the conductor containing the hot gases and force them out, which we will notice is not a pulling power but a direct forcing power due to the differential pressure between the hot gas and the cool air. Now then, so far as anybody designing a stack that will just fit a certain furnace, nobody would do that. The stack will be designed to cover all of draft requirements in sight. Then the draft openings which are always arranged for some kind of control are adjusted to cut the capacity of the stack down to fit the amount of air necessary to burn the amount of coal required and at the same time to maintain perfect combustion as nearly as possible.

Why does the stack smoke? Mr. Mingle says the stack is too small in diameter or not high enough or a combination of the inequalities of both.

I have examined a great many stacks, and I have found by far more smoky stacks that are a result of too much excess air than any other one thing that might be wrong with the stack. It is self-evident, that short, small stacks do not create a condition of too much excess air.

I am willing to admit that some stacks are too small. They are not high enough and not large enough in diameter, but they are very few, rather than the majority of the stacks in this country, as Mr. Mingle says. So far as smoke is concerned, that is the least of the job of making an economical stack.

It also must be remembered that whenever an underfeed stoker is installed on one of Mr. Mingle's short stacks that 50 per cent of the draft loss passes out of the problem because all underfeed stokers must have forced draft which takes care of the loss of draft through the fire. Of course, any forced draft will do the same thing. I will say this, that if the excess air is cut down to normal and the draft over the fire is just enough negative to carry the results of combustion away, there will be no smoke and therefore no abatement will be necessary and industry will be very much compensated for ridding their community of black smoke. Nobody can afford to allow their chimneys to smoke, no matter from what cause; if in the extreme case it takes a new stack, then a new one it should be because dirty stacks, as a rule, are wasting at least 20 per cent of the heat of coal which loss would amply pay for correcting the difficulty.

[1]Page 66. December 1940.

The municipality that thinks that smoke abatement is purely a legislative problem, better reconsider. It will save them much smoke, many friends, and a bank balance on the part of industry.

WM. H. GROVER

Perrysberg, Ohio.

Pulverizer Pete's Prize Contest

INTEREST in Pulverizer Pete's great prize contest announced in the January issue has exceeded all our expectations. The letters are pouring in at the rate of two a month; in fact, it may prove better than that. So far, and it is only the 13th of the month we have received one reply. Naturally, we are tremendously tickled about this but rather than run the risk of overloading our mailing department we have decided to put an end to the contest by publishing the correct answer. Using Pete's own wording, this is as follows:

"Sell the junk and buy some postage stamps and stationery." EDITOR.

Luminous Flame Firing

THERE HAS been considerable discussion on the subject of Luminous Flame—probably sufficient to make it possible to draw some conclusions. By way of pointing out the issues and in order to be able to carry the discussion a step further, we might recapitulate as follows:

R. C. Vroom brought out the importance of flame temperature and flame emissivity but stressed the former. The writer took issue with Mr. Vroom's tendency to pass over the matter of emissivity as of no consequence and added that the increased emissivity of a luminous flame more than compensates for the reduced flame temperature. G. C. Kohlar supplemented this discussion with a more thorough analysis of the subject of flame temperature and emissivity, reaching the conclusion that . . . "the increased luminosity will raise the emissivity of the flame and the Stefan Constant more than enough to offset the drop in flame temperature."

In part then, Mr. Kohlar supports the earlier statement made by the writer. He however brings in the Stefan Constant in connection with emissivity as a factor in compensating for lower flame temperature and this is not disputed here. J. R. Darnell next entered the discussion, but in his material tended to overlook the immediate issue which is: whether emissivity is an important factor and whether it serves to compensate for the reduced temperature. Instead he tries to prove, by quoting from the book by Haslam & Russel, that a luminous flame would not be of as high a temperature as a non-luminous flame, a point on which there is no disagreement whatsoever.

The only conclusion to be drawn from all this, then, is that the heat transfer from a luminous flame, which has a higher emissivity and Stefan Constant, will more than compensate for the reduced flame temperature. Or putting this into plain language, the radiant heat transfer is higher with a luminous flame than it is with a non-luminous flame.

The next issue is whether the heat transfer to a boiler and to metal in a heat treating furnace, increases with the use of luminous flame. Simplifying the matter, it can be said that both the boiler and the heat treating furnace are heat absorbing bodies. The former being water cooled, however, abstracts heat at a faster rate than the latter, which is a solid body.

Here again it will be of interest to review the opinions expressed and it is noted that Mr. Kohlar says, in essence, that heat transfer by convection in a boiler, is considerably reduced with a luminous flame. Mr. Darnell gives a reason why luminous flame helps industrial furnaces, but overlooks the question at issue, namely: why it does not also help the boiler. Thus since only Mr. Kohlar ventured a reason as to why luminous flame reduces the heat transfer to a boiler, I may add to his remarks by pointing out the following:

Heat transfer by convection, contrary to the general belief, is very low in water tube, water walled boilers, or generally about 25 per cent. H. G. Lykken, in an article entitled "Every Good Boiler Must Be at Least Fifty Per Cent Furnace," published in the July, 1932, issue of *Power*, gives some specific data on this subject of heat transfer by convection versus radiation. The following quotation which has reference to the amount of radiation which takes place in a boiler operating at maximum efficiency, may throw some light on the matter under discussion.

"It therefore becomes apparent that, if we generate the gas at a temperature of 3500 deg. F. and if it must not be in excess of 2000 deg. F. as it leaves the furnace, there must be heat removal equivalent to at least 1500 deg. temperature change while the gases are yet in the furnace. This temperature difference represents . . . about 50 per cent of the heat available in an ordinary boiler installation whose exit flue-gas temperature is around 500 deg. F."

It will be noted that this figure of "about 50 per cent" absorption by radiation, is based on maximum boiler capacity. The average boiler, however, is operated at varying loads and it is a known fact that absorption by radiation increases markedly as the load drops. It can therefore be said, and with a good degree of assurance, that the average steam plant will operate at very close to 75 per cent absorption by radiation.

Now to get out of the realm of theories and abstractions and into the field of practical application, it may be profitable to note that a boiler operates at about 70 per cent efficiency while an industrial furnace operates at about 10 per cent efficiency. In other words, a 1 per cent raise in the efficiency of a boiler would mean a saving of about 1.4 per cent of the fuel. A 1 per cent increase in the efficiency of a furnace though would mean a saving of about 7 per cent of the fuel. It is therefore clear that the effect of heat transfer in a boiler is small as compared with the effect of such heat transfer in a furnace. So far as increase in capacity is concerned, the same applies, namely, that where an increase of 1 per cent would be obtained at the boiler, there would be a five-fold increase in the case of the furnace.

It can thus be seen that heat transfer by luminous flame is of greater consequence and importance in the field of industrial furnace application than it is in the field of steam generating application. This results in the tendency to assume that the luminous flame yields no advantage whatsoever to a boiler installation, and that it is only advantageous to the industrial furnace. Just because an advantage is small, there is no justification for concluding that such an advantage is entirely non-existant.

ZUCE KOGAN,

Chicago, Ill. Consulting Engineer.

Report Accidents? Here's One

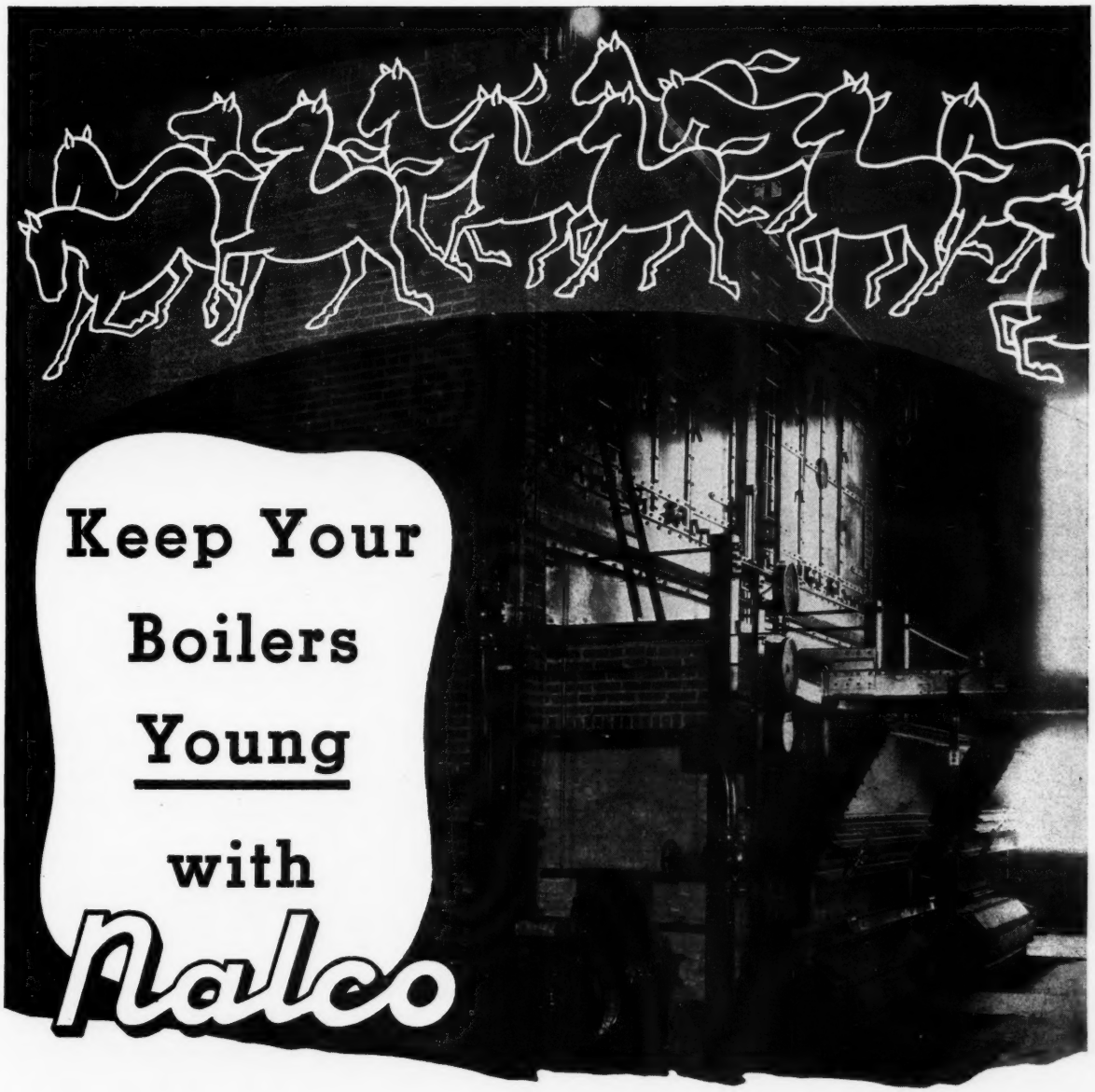
UNDER THE heading, "Report Accidents" by Charles Parks in the December issue, it is suggested that readers report accidents in your pages. Here is an account of a very close scrape, with the salient facts boiled down.

We have 6 water-tube boilers in our plant. The main feed pump is turbine driven and the auxiliaries are of the duplex reciprocating type. Three injectors supplement the auxiliary feed pumps. Recently the operator coming on watch to relieve the night shift noted that a smell of a hot bearing pervaded the engine room. He inspected the main units, and found everything ok. Coming to the turbine driven feed pump, which had been on the line for the eight hours preceding, he found that the outboard bearing of the turbine was beginning to smoke. He started the auxiliary feed pump and cut the main out. After it had cooled down, we inspected it and the cause of the trouble seemed to be the fault of the lazy night oiler. The babbitt had begun to soften and the operator had just caught it in time. We re-lined the bearing and put it back in place, starting the unit up the following day.

About three that afternoon, it began to smoke again. The chief had us cut in the auxiliary, but continued operating the main, with suction open, discharging to the sewer. On closer examination of the bearing there appeared to be a small jet of steam leaking past the forward sealing gland and impinging on the face of the bearing.

We opened it up and found that a small, uneven path had been worn at right angles to the labyrinth packing. The packing ring had to be renewed. It was made slightly oversize to protect the ridge cut in the shaft by the steam. A convex guard was fitted to the bearing, to protect it and to direct the steam upward, should this condition ever occur again. TYLER G. HICKS

New York, N. Y.



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ACTUALLY your boilers may have seen a good many years of service, but if you use the Nalco System to keep them continuously clean . . . free from scale . . . and protected against corrosion, you can go a long way towards getting performance fully as good as when they were new! The results secured with Nalco treatment are attested by typical reports from users: "BOILERS CONTINUOUSLY CLEAN OVER LONG PERIODS OF TIME" . . . ELIMINATION OF MUCH MAINTENANCE AND CLEANING COSTS" . . . "SAVINGS IN CHEMICALS" . . . "INCREASED BOILER CAPACITY". We will be pleased to give you complete information about Nalco service.

Write to NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Ill.

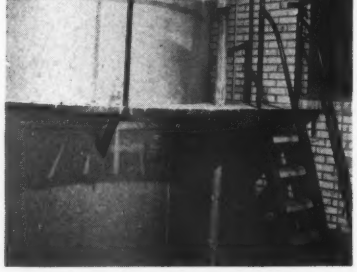
The Nalco System of Feedwater Treatment

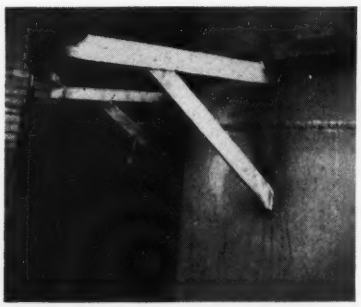
Canadian inquiries should be sent to ALUMINATE CHEMICALS, LTD., 372 Bay St., Toronto, Ont.

SHOP TALK

A department showing by means of photographs how engineers in various plants have overcome certain obstacles or devised methods to facilitate operation. If you have done something along similar lines that you are proud of or which you feel may be of interest to others, send us a picture and a paragraph of explanation. If the photograph is good and if the idea is original we will present it on this page and pay you for it.

CATWALK—Accessibility always makes for good operation and maintenance. The two photographs presented here show how Leslie Bradley constructed a catwalk around the top of the water treating tank in his plant at Bismarck, N. D. This tank has an

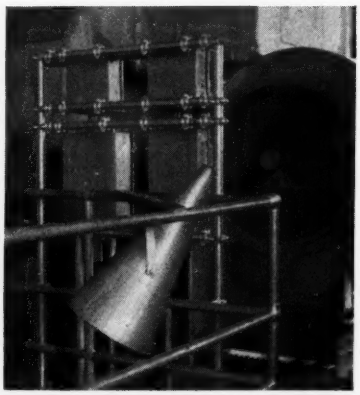




agitator inside for the purpose of mixing lime in the raw water. The tank is about 15 ft. high and 10 ft. in diameter. The photo at the right shows how angle irons were welded to the tank by arc weldings and the other picture shows the completed job. Two by six planks were used for the floor and 2 by 2 angle iron forms the framework.

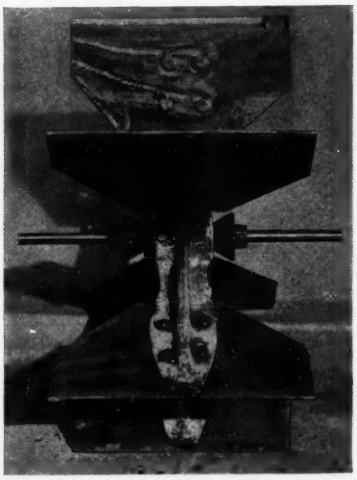
BLUEPRINT FILE—A puzzle for the operating department is where to file large blueprints which are referred to frequently so that they are convenient yet kept in usable condition. After trying a number of different methods at Riverside Station of the United Power Mfg. Co., Davenport, Ia., tables were found to be the best solution. Fifteen or 20 are bound together with index tabs as shown and kept flat on the table. Each bundle has a cover, fitted with two handles, made from light sheet metal. This acts as an effective paperweight and at the same time keeps the prints clean and flat. Will Weise, engineer, who uses them most, feels that it is much more convenient and practical than either flat or vertical files. As shown below the arrangement is simple, neat and effective.

OUTMODED — This megaphone on the feedwater gallery of Riverside Station (United Power Mfg. Co., Davenport, Ia.) has been relegated to standby service by the installation of a loud speaker system. Hung so that it can be moved either vertically or



horizontally, it was always available to facilitate conversation between the feedwater tender and those on the firing floor far below and is still retained for emergency use. It is an idea applicable to many of the smaller stations where a loud speaker system is not justified and where noise makes communication difficult.

REPAIRING BLOWER BLADES—Many industries transport fine materials by blowing them through pipes by means of centrifugal fans or blowers. In one plant transporting clay and talc in this manner, the blades wore completely through in a short



time. As shown in this picture submitted by C. C. Pandrell of the Haynes Stellite Co. of Los Angeles, the life was increased approximately 3 times by hard-facing the blade with four rows of Haynes Stellite Alloy rod at the entrance corner of each blade.

With this unique method of hard-facing, the abrasion eventually wears holes in the steel between the hard-facing deposits—but only after much longer service.

For Service where Dependability is really Essential • • •

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CHECK VALVES

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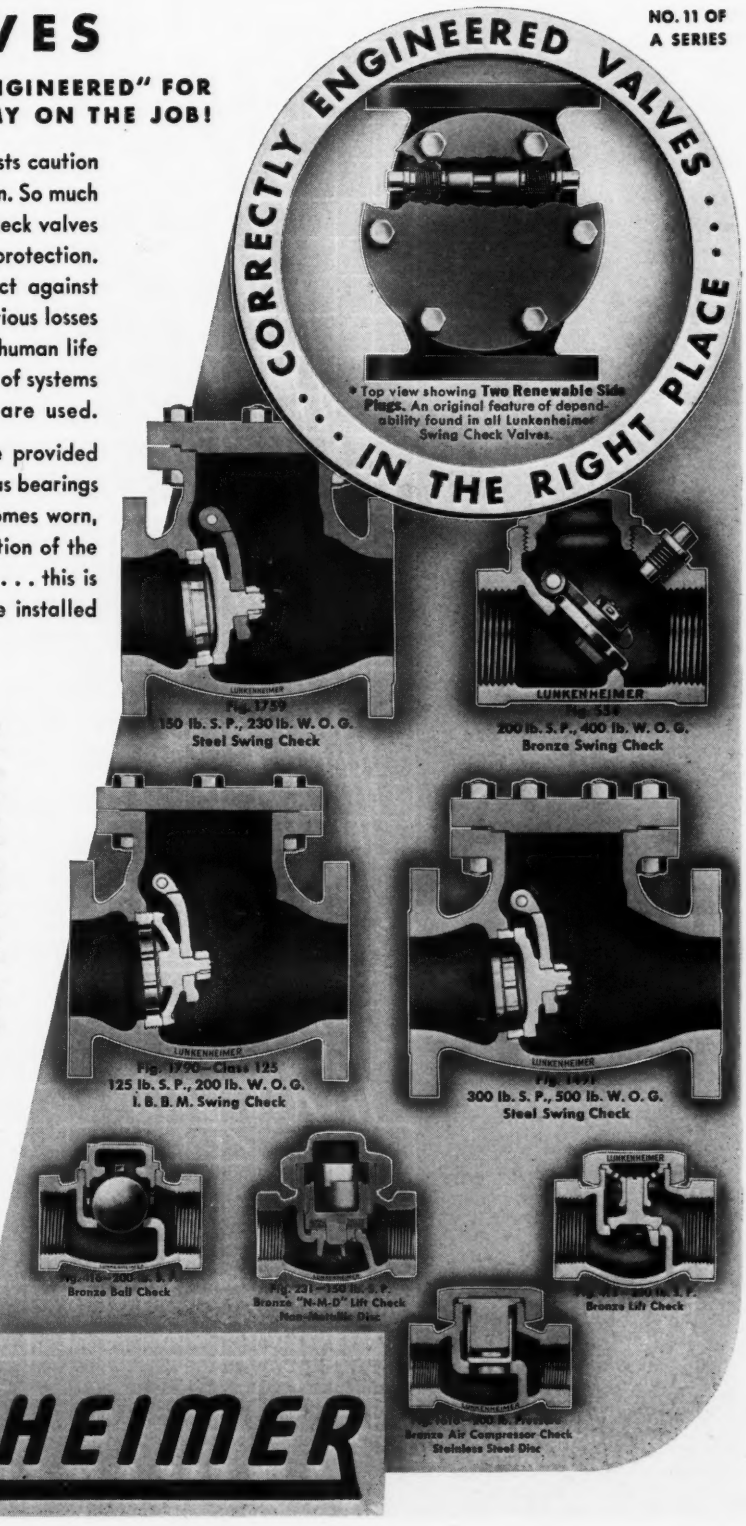
All Lunkenheimer Swing Check Valves are provided with two renewable side plugs which serve as bearings for the disc carrier pin. In case a pin becomes worn, causing misalignment and impeding operation of the valve, it can be removed from either side . . . this is particularly advantageous when valves are installed in tight places, such as close to a wall.

SEEING IS BELIEVING

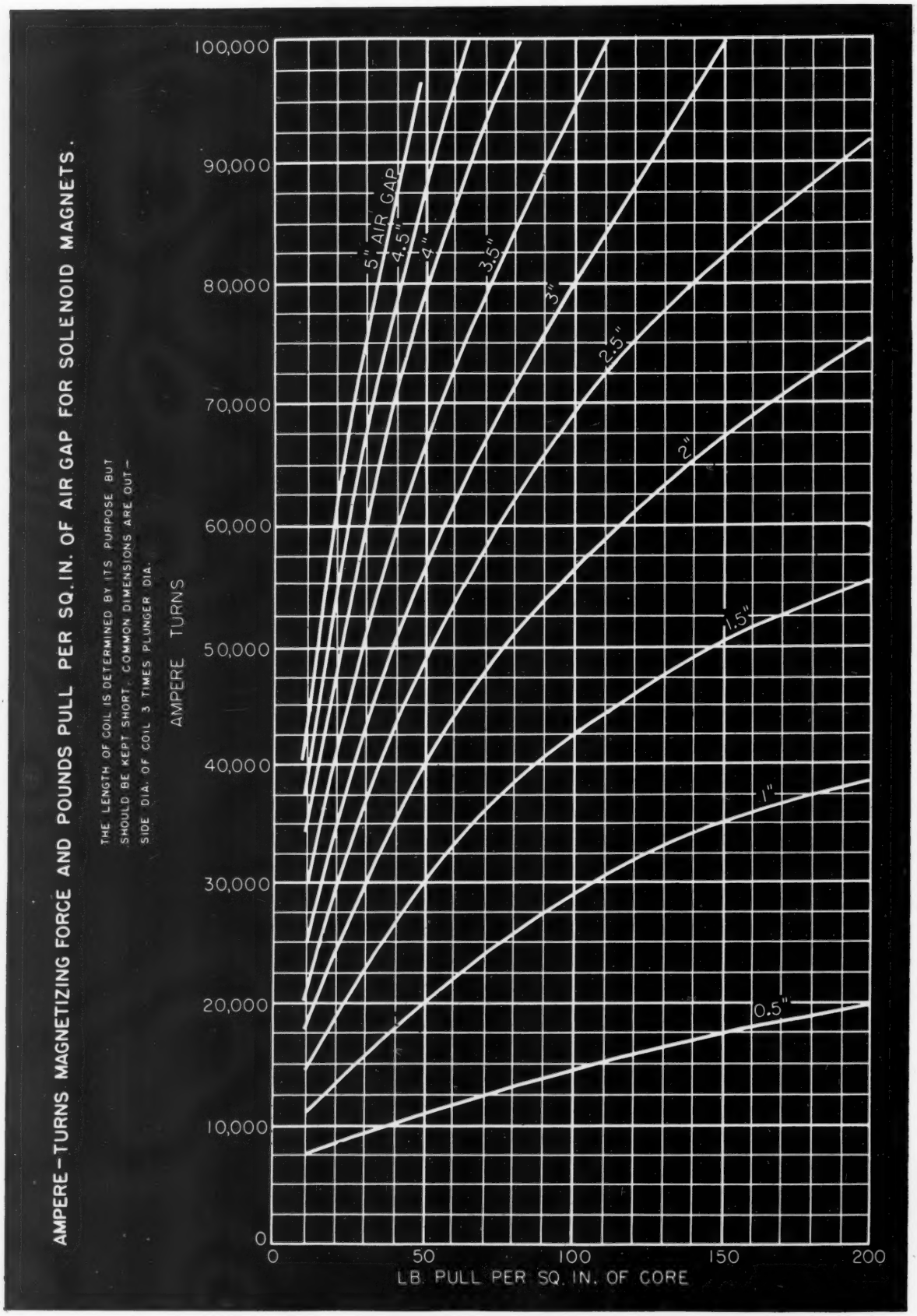
We cannot hope to take every prospect and every buyer through our plants but we welcome the opportunity whenever possible because then he can see with his own eyes the minute care exercised in the selection of materials . . . in the scientific research of their physical properties . . . the close tolerances maintained in machining all parts . . . finally, the thorough and complete test each and every valve must undergo before receiving a final okay. However, as an alternate, we do suggest that you ask your Lunkenheimer distributor to take a valve apart and let you see for yourself how carefully they are constructed to give you safe, long time, trouble free service. In short, to show you what we mean by "Correctly Engineered Valves."


CORRECTLY ENGINEERED VALVES
IN THE RIGHT PLACE
• Top view showing Two Renewable Side Plugs. An original feature of dependability found in all Lunkenheimer Swing Check Valves.
LUNKENHEIMER
Fig. 1759
150 lb. S. P., 230 lb. W. O. G.
Steel Swing Check
LUNKENHEIMER
200 lb. S. P., 400 lb. W. O. G.
Bronze Swing Check
LUNKENHEIMER
Fig. 1790—Class 125
125 lb. S. P., 200 lb. W. O. G.
I. B. B. M. Swing Check
LUNKENHEIMER
300 lb. S. P., 500 lb. W. O. G.
Steel Swing Check
Bronze Ball Check
Bronze "N-M-D" Lift Check
Non-Metallic Disc
Bronze Lift Check
Bronze Air Compressor Check
Stainless Steel Disc

ESTABLISHED 1862
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

Send for copy of our new Catalog No. 78. We will include our handy "Guide", for easy selection of valves, boiler mountings, and lubricating devices according to pressures, temperatures, and service applications.

LUNKENHEIMER


AMPERE-TURNS MAGNETIZING FORCE AND POUNDS PULL PER SQ. IN. OF AIR GAP FOR SOLENOID MAGNETS.
THE LENGTH OF COIL IS DETERMINED BY ITS PURPOSE BUT SHOULD BE KEPT SHORT. COMMON DIMENSIONS ARE OUT-SIDE DIA. OF COIL 3 TIMES PLUNGER DIA.
AMPERE TURNS
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
0
50
100
150
200
LB. PULL PER SQ. IN. OF CORE
5" AIR GAP
4.5"
4"
3.5"
3"
2.5"
2"
1.5"
1"
0.5"

Pensacola Dam Completed

(Continued from Page 73)

ply for any purpose equals any city standard; a separate sewage disposal system was installed downstream to avoid the comparatively slight stream contamination possible.

On the mezzanine floor are located the operations superintendent's office, visitors' observation gallery, men's and women's rest rooms. There is un-allotted space sufficient for a dispatcher's office when demand shall require, also for offices of the Grand River Dam Authority itself if that is desired. This space at present is open gallery overlooking the generator floor.

Observation of the dam from downlake reveals that it is remarkably dry; small trickles visible from the powerhouse may still be curing water.

Statistics

Drainage area in Oklahoma, Kansas and Missouri	10,415 sq. mi.
Lake area, pool at 745 ft.	46,295 acres
Water impounded	1,680,000 ac. ft.
Shore line	1,000 miles
Pool length	65 miles
Spillways capacity per second	525,000 cu. ft.

Main and mezzanine floor surfaces are terrazzo. Wall finish is all concrete of course; interior walls on generator and mezzanine floors are painted light blue with darker blue-tile wainscot. Pillars are blue-tile wainscoted. All trim, hand rails, and doors are aluminum.

Roadway across the dam is lighted by 1,365 100-watt lamps behind diffusing reflectors built into the guard rail on the downlake side and the railing separating walk from the roadway. An observation platform for uplake was built somewhat to the east of the intake structure.

Normal production capacity (primary 100% of time) is 200,000,000 kilowatt hours yearly. The cooling system for generator was designed so as to permit overloading with most safety. The system may be run in units of one, two, three or four blowers of 65,000 cu. ft. per min. capacity each. When needed, heating is supplied by plug-in electric heaters.

Main transformer units in the switchyard atop the bluff are four 16,000 kv-a. stepping the 13,800 volt output up to 66,000 and 110,000.

Relocation of rail lines and highways, building of new bridges and removal of old bridges is practically completed. One small town, Bernice, Oklahoma, has been removed, its site inundated.

Between Miami and Fort Gibson, Oklahoma, Grand River falls 240 ft. This dam utilizes only 120 ft. of that fall. There is under consideration the building of two smaller dams between Pensacola and Fort Gibson, to utilize the impounded water from this dam, known popularly as Grand River Dam, in that 120 ft. fall and increase the project's total power output to nearly 450,000,000 kw-h.

Pensacola Dam Construction Quantities

	Dam Proper	Entire Project
Earth excavation	1,430,000 cu. yd.	2,870,000 cu. yd.
Rock excavation	270,000 cu. yd.	590,000 cu. yd.
Cement	625,000 bbl.	655,000 bbl.
Concrete	510,000 cu. yd.	535,000 cu. yd.
Reinforcing steel	18,000,000 lb.	20,000,000 lb.
Structural steel	5,870,000 lb.	10,000,000 lb.
Copper	75,000 lb.	

From the bluff down to the mezzanine floor of the powerhouse a winding stairway leads by easy stages; this is one visitors' entrance for use at any time; another is at the east and is reached by road. Staff men, estimated at 15 normally, will use the elevator. This mezzanine floor, outside, is a deck with a circular rampart from which downstream may be observed, and with other, rectangular, spaces for observing the bluff and the dam. Persons may look through the steel-sash windows into the powerhouse or go inside and look down on the generator floor. The mezzanine deck and generator floor have removable hatches through which access to the "house supply" generator may be had. From it also, by means of circular stairway, a valve room, isolated for safety, may be reached.

Bearing Cooling

FOR MANY YEARS steam turbine bearings, running at far higher surface speeds than any internal combustion engine, employed water jacketing to remove heat from bearings. Lately by opening up bearing clearances and increasing supply pressure, enough oil is flowed across the bearing to carry off the heat, and jacketing is eliminated. Incidentally turbine operators use coolers to hold oil temperature down to a maximum of 150 deg. F., and they expect an oil to stay good for six or seven years, not for 60 or 70 hr. The main reason they succeed is—low oil temperature. In the internal combustion engine, lubrication is really the small end of the job; the major one is cooling. Jacketing bearings is generally out of the question; only one has appeared—Harry Ricardo's design on which cooling liquid is circulated through the crankshaft. The only recourse then is to provide higher circulation of oil, and if necessary provide external coolers since the crankcase is an exceptionally poor oil cooler—thick layer of oil, slow flow, hot top to the crankcase.—*R. J. S. Piggott before the S.A.E.*

Power Generation in Milwaukee

By John E. Hubel

FOR ABOUT half a century the city of Milwaukee has been generating current for certain public buildings. A few months ago, the generating plant of the city hall was discontinued at a saving of about $20,000 a year. According to a recent report given out by the city engineer, Joseph E. Schwada, the generating plant of the public museum may soon be discontinued. This plant costs the city $46,577 for light, heat and supplies while current from the local utility would, it is estimated, cost the city about $32,000.

If continued in service the plant would have to be modernized at a cost estimated at $86,350, although this would reduce the cost per year to about $43,980. On the other hand, if power is purchased, the change over from direct to alternating current will involve an expense of somewhere from $90,000 to $100,000 or a trifle more than the modernization would cost. Space now occupied by the power plant would be used for other purposes as it is badly needed.

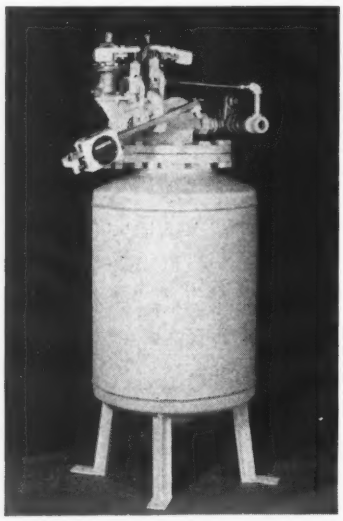
Milwaukee has a central heating system for the downtown district. Abandoning the boiler and engine room will release a space of about 70 by 35 ft. for other museum purposes.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Steam Drainer and Boiler Feeder

FROM AN EXPERIENCE of more than 40 yr. in the steam drainage and boiler feeding field, the Morehead Manufacturing Co., Detroit, Mich., announces the Morehead Direct Pressure Liquivator adaptable as a drainer for all types of steam-heated radiation, cooking, drying, evaporating and processing equipment under either vacuum or pressure conditions, or, for boiler feeding.



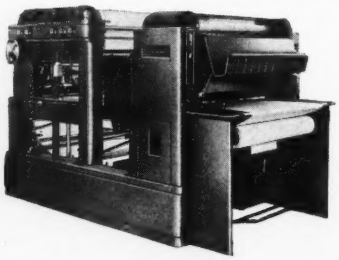
As boiler feeders, they return condensate to the boilers at the original high temperature of the condensate return. These Liquivators are built in metering and non-metering type and both can be furnished with remote control or self-contained assemblies, offering unusual flexibility of application. Specially built Liquivators can be obtained to meet particular conditions.

They are built in six standard sizes ranging in the capacity from 40 to 280 lb. of water per charge and can be used for any industrial application for handling and transporting liquid where steam, air or gas pressure is available as a motivating medium.

Continuous Blueprinting Machine

BY COMBINING a blueprinting machine with a washing and drying machine into one unit, the C. F. Pease Co., Chicago, Ill., has developed its Model 22-16 continuous blueprinting machine to meet the wishes of commercial blueprinters, industrial plants and government departments.

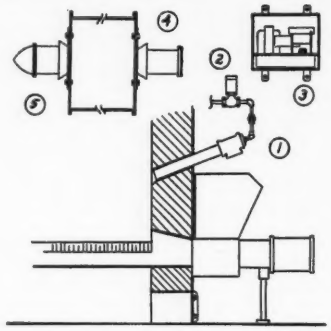
In the operation of this machine, sliding contact smoothes out all inequalities present in tracings and gives 24¾ in. of uninterrupted exposure area. Three-speed lamp control is provided which allows the lamps to be operated on 10, 15 or 20 amp. as desired. The drying element in-



cludes a horizontal water wash arrangement that floats the exposed paper horizontally, free from tension and wrinkles, a quick change chemical applicator which permits a rapid change-over from blueprints to negatives, and five 8-in. aluminum drying drains heated with either gas or electricity. This combination machine has a speed of 15 ft. per min.

Smoke Consumer and Indicator

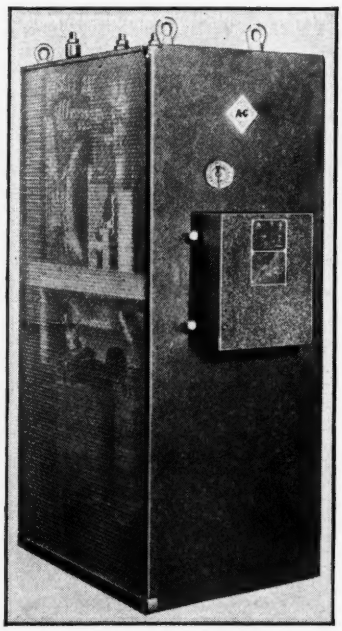
UNIVERSAL SIGNALLING EQUIPMENT, Cincinnati, Ohio, announce their smoke consumer and indicator which has a specially designed steam-air eductor mounted in the furnace setting and directed over the surface of the fire 1; an electrically operated steam valve 2; a relay cabinet 3; and, the photo-cell and spotlight tubes 4, 5, which are



mounted on the stack or the breeching. Smoke intercepting the spot-light beam on the photo-cell, closes the relay mechanism which in turn opens the steam valve of the smoke consumer element. The rotating blast of preheated air from the steam-air eductor disrupts the stratification of the hot gases and the unburned volatile matter issuing from the fire bed, and causes immediate combustion of the escaping carbon monoxide gas and smoke forming elements, thus acting to materially increase furnace efficiency. The system can be furnished with a recorder which is invaluable in making fuel and furnace tests. It is designed and custom built for all sizes and types of steam plant furnaces, any number of which can be controlled from a single relay cabinet.

Dry Type Regulator

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., announces a completely new dry type air-cooled regulator for feeder voltage regulation available in ratings of 36 kv-a. to 96 kv-a., 2400 v. single phase. This new unit embodies the inherent advantages of low exciting current, low losses and fine regulation.

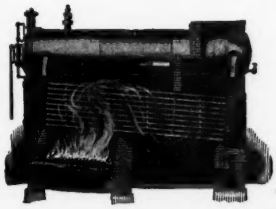


The regulator is of the step type having thirty-two ⅝ per cent steps to provide ± 10 per cent regulation. The transformer is completely air-cooled without blowers or forced ventilation of any kind and the tap changer operates in air without lubrication. The unit has a wide application in indoor sub-stations where reduction of fire hazard is of vital importance and where it is generally undesirable to have special non-inflammable insulating liquids.

Elimination of oil makes fire proof vaults unnecessary and does away completely with periodic maintenance and filtering of oil. Dry operation permits of easy inspection, as the mere unlatching of a door makes all working parts readily accessible.

"Time Marches On"

1864



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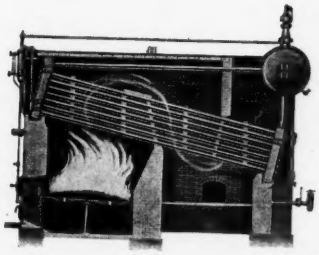

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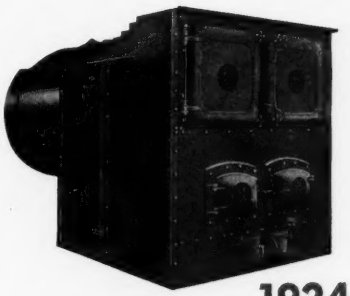

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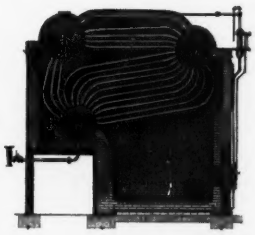


1930

The illustrations on this page show developments in the design of steam boilers since Civil War days. In the same year (1935) that Chicago was celebrating a "Century of Progress," the E. Keeler Co. announced the Keeler C. P. Steam Generator, illustrated below. With its insulated steel cased water walled setting, outperforming all previous designs and remarkable for its low cost of maintenance, this unique boiler is the last word in boiler design.

C. P. Steam Generator

1935

One user writes: "I didn't realize how antiquated my old boilers were until I installed a Keeler C. P. Steam Generator." After two years use another customer writes: "Since this boiler has already paid for itself, we feel that our judgment in selecting this equipment has been thoroughly vindicated."

Over five hundred units are now in use or on order. Mail the memo below for latest descriptive bulletin. It points the way to cheaper steam.

E. KEELER CO.

WILLIAMSPORT, PA.

Please send copy of Bulletin F-9

Name .....

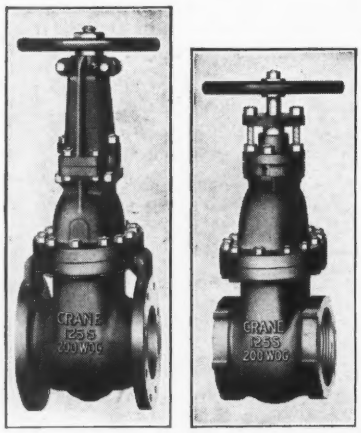
Title .....

Firm .....

Address .....

New Line of Iron Body Valves

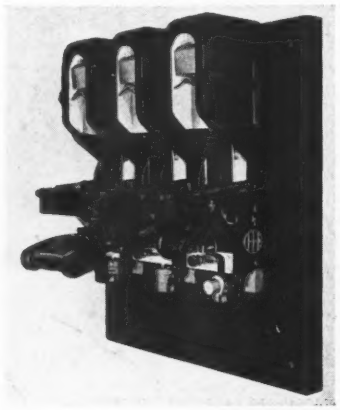
INCLUDED in a new and complete line of standard iron body wedge gate valves for 125 lb. steam, 200 lb. cold working pressure just brought out by Crane Co., Chicago, Ill., are both the brass trimmed and the all iron patterns with O. S. & Y. or non-rising stem, in sizes 2 to 12-in., inclusive. Also, the quick opening and the Underwriters' patterns, the alloy trimmed, alloy cast iron valves for process work, and the standard iron body valves for marine cargo oil systems.



Redistribution of body and bonnet materials, which eliminates all excess weight and yet complies with all standard requirements is one of the important features of these valves. Handwheels are of malleable iron; deep stuffing boxes permit a generous amount of packing; the body-bonnet joints employ a flat gasket closely bolted together so that gasket compression is evenly distributed; seat rings are of the shoulder type to retain tight contact with the body in spite of the difference in expansion characteristics.

Circuit Breaker

THE I-T-E Circuit Breaker Co., Philadelphia, Pa., announce their newly improved Type LX Circuit Breaker. The particular breaker illustrated is a 3 pole device equipped with 3 direct acting overload and inverse time delay features, and is trip free of the handle, and is available in ratings from 100 to 1600 amps., 250 v., D. C., 600 v., A. C. The new Arc Quenchers developed for this device have magnetic vanes molded into the insulating barriers on each side of the main contacts. They are magnetized upon opening of the arcing contacts, and the field set up by the current forces the arc into the extinguisher chamber. In this chamber thick copper plates are arranged to cool the arc, create a turbulent gas condition and provide a cooling draft across the arc core. The materials selected and the arrangements made are such as to give maximum thermal capacity or minimum heating in the plates, maximum thermal and electrical conductivity and maximum turbulence of the gases. No deterioration results when interrupting circuits within the rated interrupting capacity of the circuit breaker.



Checking Steam Carry-Over

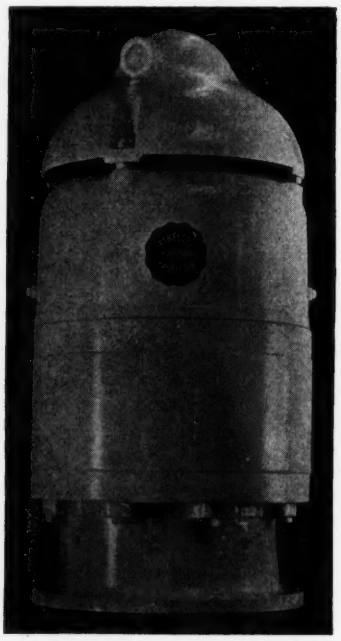
INDUSTRIAL INSTRUMENTS, INC., Jersey City, N. J., announces its Solu-Bridge Controller as an aid to the control of boiler foaming and carry-over of corrosive salts and solids by steam to the turbine and other equipment. The instrument may be set to give an alarm when the carry-over of sodium chloride exceeds a predetermined limit in parts per million, or, by the twist of a knob, the boiler attendant can check the carry-over at any particular time.

As installed in an eastern boiler plant, a ¼-in. steam pipe from the boiler header is brought down to the condenser to which city water circulates for cooling purposes. The condensate then passes over a conductivity cell and goes to waste. The conductivity cell is wired to the remote controller which is installed some distance away near the stokers.

The controller itself has two knobs: a calibrated knob set for the temperature of the condensate; and a main knob which operates in conjunction with a magic eye indicator. The dial of this main knob is calibrated directly in parts per million $NaCl_2$. When the conductivity reading is at the left of the predetermined setting, the instrument may be arranged to operate a warning light, ring a gong, or operate a recording instrument.

Explosion Proof Motors

U. S. ELECTRICAL MOTORS, Inc., of Los Angeles, Cal., and Milford, Conn., has recently developed a vertical explosion proof motor, suitable for vertical applications in those locations in which flammable volatile liquids, highly flammable gases, mixtures or other highly flammable substances are present; also in which combustible dust is present as in flour or feed mills, grain elevators, starch plants, and coal pulverizing plants.



The unit is fan-cooled, with asbestos-protected windings which are important as explosion proof motors are rated 55 deg. C. rise or 37 per cent higher than standard motors.

These motors are offered with a variety of mounting brackets to any machine without additional adaptors or plates.

New Air Grinder

INGERSOLL-RAND CO., Phillipsburg, N. J., has recently added a new baby air grinder to its line of pneumatic tools. This tool, called the Size 00, weighs only 1¼ lb. and operates at 20,000 r.p.m. at 90 lb. pressure. It is built to take 1½-in. diameter organic bonded or 1¼-in. diameter vitrified wheels. Also available are various sizes of collets to take mandrel mounted grinding wheels or small twist drills.

Although originally intended to be used as a die grinder for tool room and bench work, it is now being used largely by industry for innumerable light grinding jobs wherever metal must be removed from places that would otherwise be hard to reach.

Power Plant, American Tobacco Co., Durham, N. C.

Portrait of a power plant about to PAY FOR ITSELF!

Thanks to efficient, economical COAL, the enlarged plant of the *American Tobacco Company* at Durham, N. C. will repay its cost in a few years. In the past this company used dependable, *clean*-burning coal for process steam and part of its power. Decision to increase steam capacity and generate all power meant an investment in new boiler and stoker, turbine generator, new coal bunker and conveyor. But, with coal doing the whole job right in the plant, this equipment will write off its cost in a few years. Unusual? Quite the contrary! The economies of modern, prepared coal are making such savings possible today in modern, wide-awake plants all over the country.

LET OUR FUEL SERVICE ENGINEERS LOOK FOR SIMILAR SAVINGS IN YOUR PLANT

Since it won't cost you a dime to find out, why don't you investigate possible economies in your own plant? Many a company today thanks Chesapeake and Ohio for plans that are paying back big dividends in savings on steam, fuel and maintenance costs. If you'd like our engineers to survey your plant, confer with your engineers and make cost-cutting suggestions — no obligation — just write GEORGE H. REINBRECHT, Coal Traffic Manager, Chesapeake and Ohio, 2903, Terminal Tower, Cleveland, Ohio.

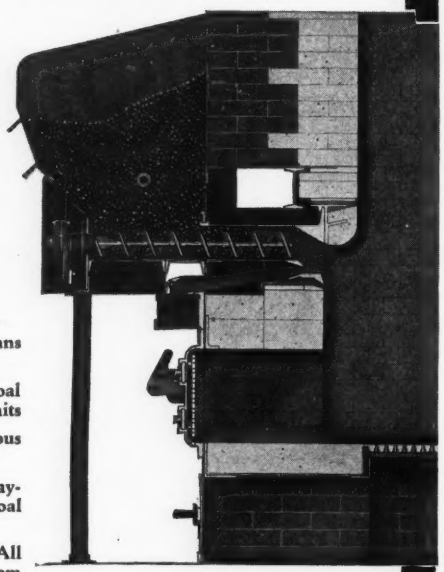
IT PAY$ TO U$E MODERN ...

Chesapeake and Ohio Lines

"We're saving $100 A WEEK" ..writes Steel Company

Find Out How FYR-FEEDER Users Cut Coal Bills Sharply

"We were firing by hand, using lump coal at about $4.87 per ton in order to keep up steam pressure. With the Fyr-Feeder we use ¾-in. slack screenings at $2.49 per ton, using very little more tonnage and having a steadier steam pressure. Our saving is better than $100 per week." . . . so writes a steel company. Many other Fyr-Feeder installations report fuel savings running from 14.5% to 58%.



These substantial economies result from Fyr-Feeder's advanced design which makes possible efficient operation with lowest priced available fuels. Among its unmatched operating features are:

- Instantaneous Ignition of Fines
- Air Spray Spreads Coal Over Grates Evenly
- Easy Fire Cleaning Because of Two or More Individually Controlled SPRAY-SPRED Units
- Large Hopper Capacity—Means Minimum Attention
- Uniform Distribution of Coal Insured by Multiple Feeding Units
- Readily Adaptable to Various Types of Boilers
- The Same Air Which Spray-Spreds the Coal—Burns the Coal Fines in Suspension
- Low Maintenance Because All Moving Parts Are Away From Furnace Heat

It will pay you to find out what this modern coal-burning system can do for you. A Fyr-Feeder Engineer will gladly call to make a survey of your coal costs or to discuss your combustion problems. Over twenty-two years of specialized over-feed stoker engineering and furnace designing experience is at your service.

Write For Fuel-Saving Data Folder

AMERICAN COAL BURNER COMPANY

153 E. Superior Street, Chicago, Ill.

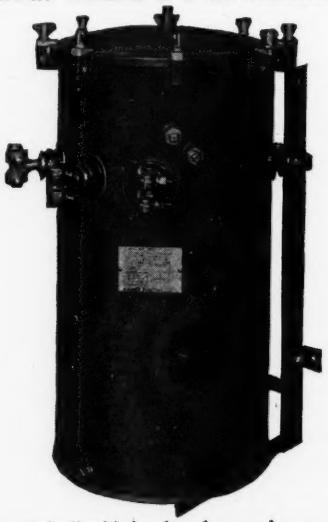
Builders of Over-feed Stokers for Over 22 Years

Spray-Spred MULTIPLE **Fyr-Feeder**

REDUCES COAL BILLS - - BURNS CHEAPEST COAL SIZES

Noflamol Transformer

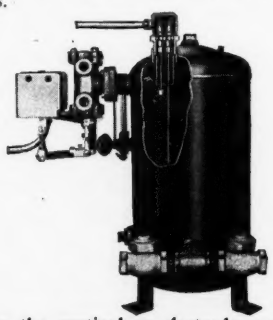
WAGNER ELECTRIC CORP., St. Louis, Mo., announces a new type transformer known as the Wagner Noflamol Transformer. Noflamol is a non-inflammable



synethtic liquid developed as an improvement over regular transformer oil, and because of its non-inflammable characteristics. These transformers can be installed indoors without the use of fireproof vaults.

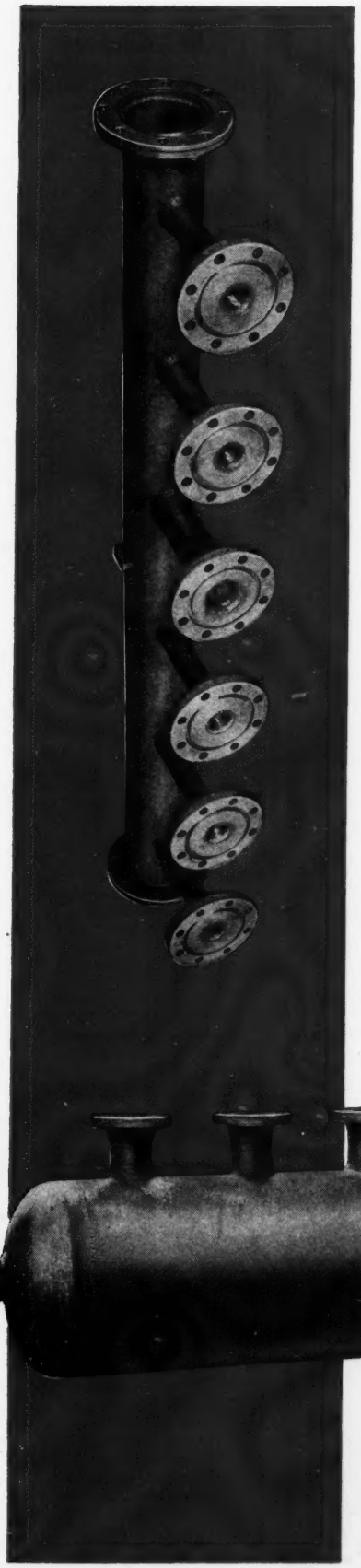
Electrap

THE JOHNSON CORP., Three Rivers, Mich., announce their new redesigned Johnson Electrap, which has electrically controlled boiler return or lifting trap and is available in sizes suitable for boilers from 20 to 200 hp., withstands pressures up to 150 lb. and discharges as much as 21,000 lb. of water an hour. All the controlling valve gear has been gathered into one compact assembly, and if the trap receiver must be installed in some inaccessible spot, this solenoid-operated steam inlet-valve can be brought out to any convenient location. The receiver has no stuffing boxes, floats, or moving parts.



In the motionless electrode control, rising water level in the trap receiver closes an electrical circuit between the two electrodes, which by means of a relay, open the solenoid valve to admit equalizing boiler pressure or lifting pressure into the trap receiver. When water level falls below longest electrode, electrical circuit is broken and solenoid valve returns to vent position.

The Electrap will serve wherever the conventional trap can be used for returning condensate to boilers, lifting or pumping water or other liquids, or draining systems under vacuum.



IMPORTANT

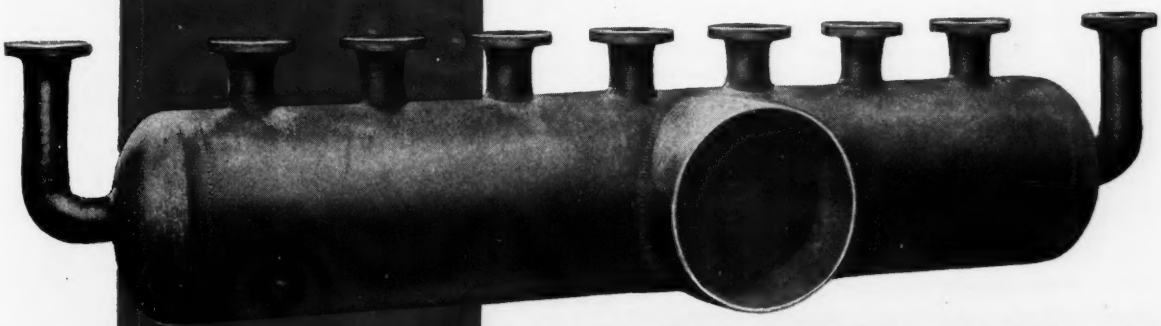
6 IN. OR 30 IN.

THE QUALITY IS THE SAME

Kellogg prefabricated piping assemblies, simple as those shown here, or as intricate as required for the most individual conditions — ranging in pressure from 200 to 2200 pounds—are installed in various power plants in this country.

Accurately prefabricated and thoroughly tested in the Kellogg shops these assemblies are shipped ready to connect, saving time and money on the job.

In fact, consulting engineers, operators of central stations, industrial and marine power plants, find that pinning the responsibility for piping on The M. W. Kellogg Company is the most satisfactory solution to their problems.



KELLOGG **THE M. W. KELLOGG COMPANY**
JERSEY CITY, N.J. · 225 BROADWAY, N.Y.
Representatives:
LOS ANGELES: 609 SOUTH GRAND · TULSA: PHILTOWER BLDG.

"Masterflex" Prefabricated Piping Systems · "Masterweld" pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units · JUIK Processes for Lubricating Oil Plants. Plastic Refractories · Radial Brick Chimneys.

Illustration shows but a few of the Fairbanks Valves on the connections to the chilled water circulating pumps of the air-conditioning system of the Famous-Barr Corp.—the fifth largest department store in the nation. The Eichler Heating Co., St. Louis, had the distinction of installing here the largest air-conditioning system ever put in a retail business in this country.

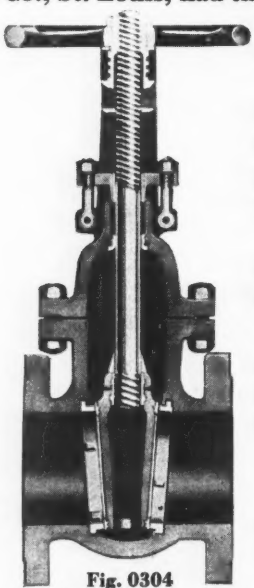


Fig. 0304
150 lbs. steam pressure

The reputation of Fairbanks Valves for dependable performance, long service and low upkeep cost is national. If *you* knew more about these valves you, too, would use them.

Why not write, while you think of it, for the name of our nearest distributor and catalog No. 21.

Fairbanks Valves are made in bronze and iron for a large range of pressures, in globe, gate, angle, check and cross patterns.

THE FAIRBANKS COMPANY

399 Lafayette St., New York, N. Y.

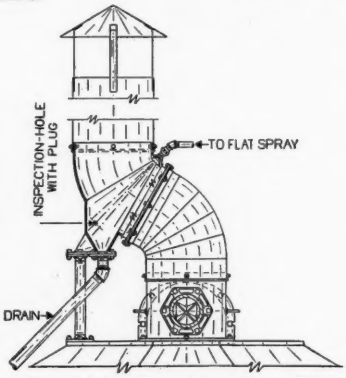
Valves, Dart Unions, Hand Trucks and Wheelbarrows

Boston, Mass., Pittsburgh, Pa.
Distributors in Principal Cities
Factories: Binghamton, N. Y., Rome, Ga.

Fairbanks F
Standard and Renewable **Valves**

Dust Collectors

FOR PREVENTING fly-ash and other solids from being carried off by the exhaust from pneumatic ash and fly-ash conveyors or from stacks, either cyclone separators or a system of water sprays have been used heretofore. Either may be: elaborate; complicate the vent or stack layout especially if draining of the waste water is involved; or involve undue back pressure.

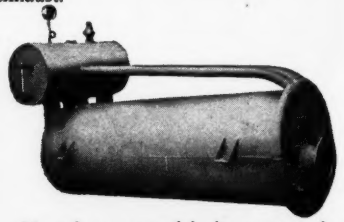


The Hahn Cast Iron Vent Elbow recently introduced by the Hahn Engineering Co., 30 Church St., New York, N. Y., has a flat water spray which cross-sections the area of the vent or stack at 45 deg. It is said by the manufacturer to cause only a slight back pressure and to form a simple, indestructible and trouble-proof device. The sheet of water-spray covers over 90 per cent of the cross-sectional area, so that practically all the solids in the exhaust come in contact with the spray-water either directly or through capillary attraction.

The waste water is collected in a pocket formed at the bottom of the vent elbow and is prevented from reaching the tank or base of the stack. Removing the plug from the inspection hole permits checking the spray-head for correct position. Also samples of the waste water may be taken from this hole for checking the amount of recovered solids that would otherwise have been carried off. These vent elbows are available in various diameters.

Waste Heat Boiler

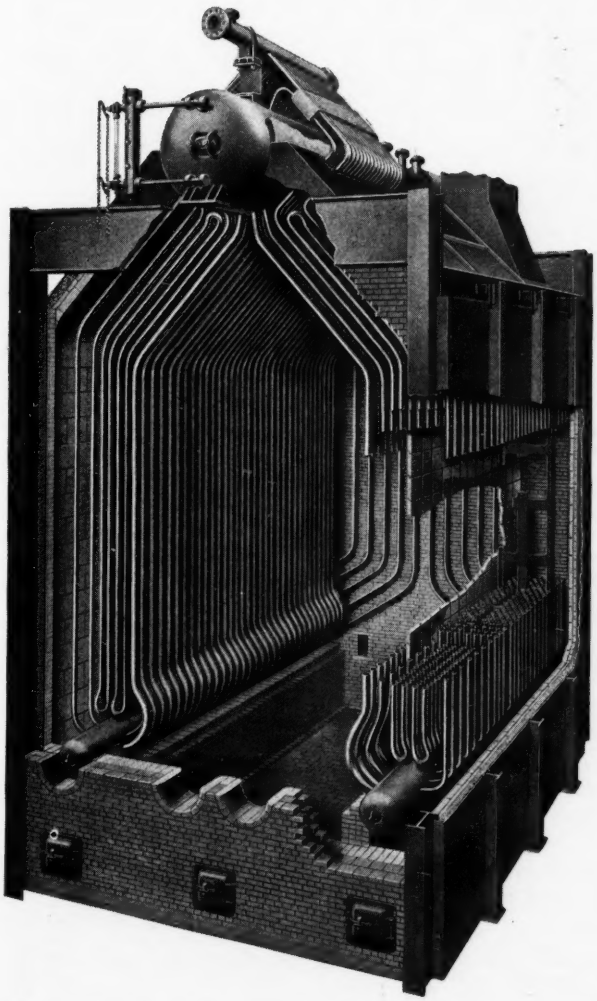
MAXIM SILENCER CO. announces the development of a combination waste heat boiler and silencer to provide efficient silencing and at the same time collect and use the waste heat normally lost in exhaust.



No tubes are used in its construction, heat being recovered by a simple arrangement of angle irons which form an extended heating surface. The device is constructed around the universal silencer principle, therefore no additional silencing unit need be used. It is combined with an efficient spark arrestor when required, and occupies little space.

S-A steaming units

The Single-flow "A"-type Steam Generator has been developed and standardized to provide an essentially practical and economic unit in capacities from 30,000 to 200,000 lb. of steam per hour.



ADVANTAGES

1. Boiler surrounds furnace:

a.) Provides a water cooled furnace.

b.) Reduces the amount of brickwork required.

c.) Gives a cool casing.

2. High Efficiency

a.) Cross flow of gases.

b.) Staggered tube arrangement.

c.) Ample length of flame travel.

3. Low Draft Loss due to single straight pass of gas through boiler.

4. Methods of Firing

a.) From front with gases entering boiler at rear.

b.) From front with gases passing to rear, reversing, and entering boiler at front.

c.) Different fuels may be fired from opposite ends simultaneously.

Accessible — Compact
Low Headroom.

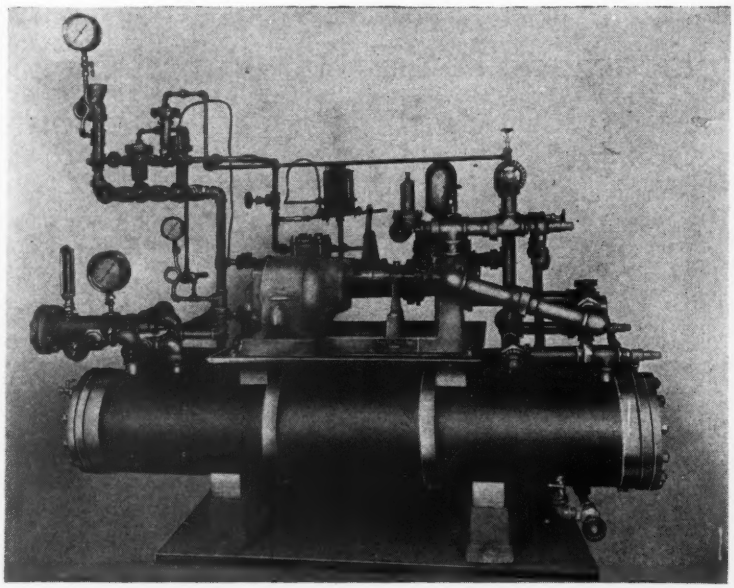
New Catalog upon request.

FOSTER WHEELER CORPORATION
165 Broadway New York, N. Y.

FOSTER WHEELER

Enco

FUEL OIL
PUMPING *and* HEATING
SYSTEMS



CAPACITIES from 100 to 5000 gallons per hour

Pumping unit systems are designed for heavy bunker oil or light furnace oil.

Single or duplicate pumps and heaters are used, each of full capacity. These are interconnected so that operation is obtained with any combination of pump and heater.

The pump may be either the steam driven duplex or the rotary or screw type driven by motor or turbine.

Heaters are of the steel shell straight tube type, insulated and jacketed with planished steel.

Fully automatic control of oil pressure and temperature with relief valves for each pump and heater. This permits the delivery of the oil with safety and at the proper temperature and pressure for efficient burning.

Complete piping so arranged that operation is obtained with any combination of pumps and heaters. Any part can be cut out of operation for inspection or cleaning.

Each unit is delivered completely built and ready to place on foundation and for connection to the station piping.

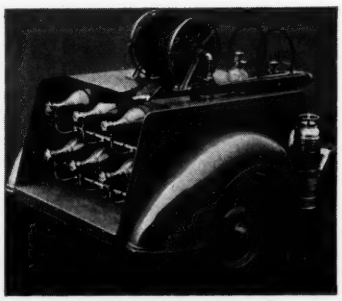
Write for Bulletin OB-40 describing Enco Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY
75 West St., New York, N. Y.

Mobile Fire Fighting Unit

DESIGNED to be hooked up as a trailer for emergency use, a compact and versatile fire fighting weapon has recently been perfected by Walter Kidde & Co., Inc., Bloomfield, N. J.

This mobile unit carries a battery of six 50-lb. carbon dioxide cylinders equipped with a hosereel and nozzle. The cylinders are manifolded together and are individually operated by valves on each cylinder. This permits employment of all or any part of the unit's capacity on a large or a small fire.



Carbon dioxide gas is discharged onto the fire through 100 feet of ½-inch hose, fed through a trunnion type manifold. Allowance is made for control of the discharge through use of a shut-off valve on the nozzle handle. This permits the discharge to be interrupted while the operator is maneuvering for position against a blaze.

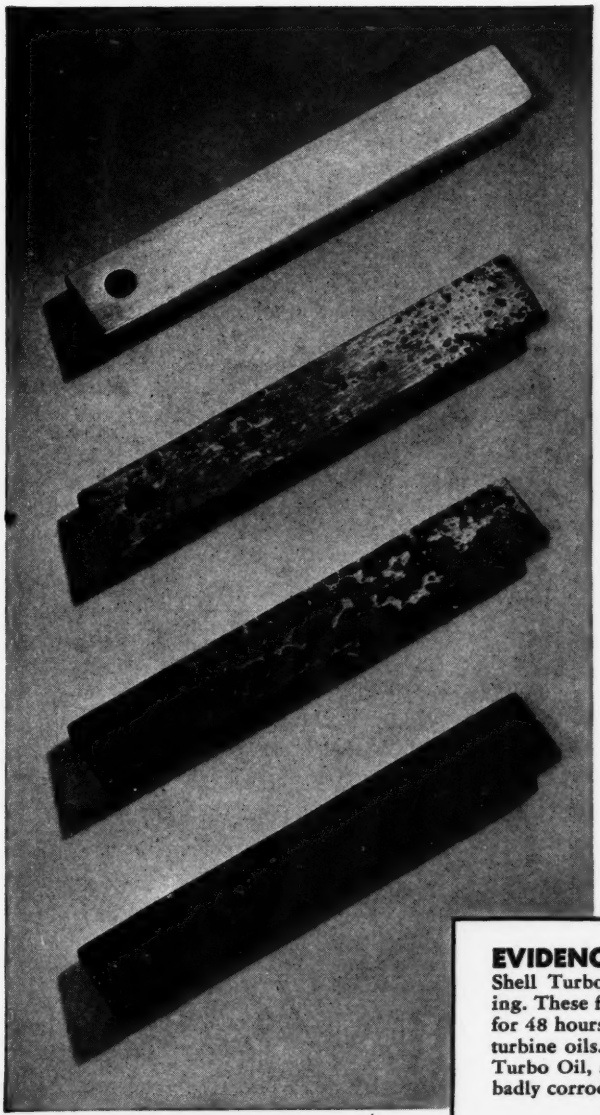
For smaller fires, two portable carbon dioxide extinguishers of 15 pounds capacity are carried on the front platform of the trailer. Also two 2½-gallon pure-water extinguishers which operate on the principle of a syphon bottle. They contain a small cartridge of carbon dioxide which is released when the extinguisher is inverted, and which propels a water stream to an effective distance of 30 to 40 ft.

It is expected that the new trailer will be employed by industrial plant fire brigades for use as first aid fire extinguishing equipment. Primarily, this trailer unit is designed for use on large fires in flammable liquids and electrical equipment. Carbon dioxide is especially effective against these two types of fire. In addition to being one of the fastest known extinguishing agents it is safe to use on live electrical equipment, since it is a non-conductor. Moreover it is clean, dry, leaving no residue, doing no damage.

New Extra Light Drills

INGERSOLL-RAND Co., Phillipsburg, N. J., has announced two new additions to its Multi-Vane drill line, Sizes 00 and 0. These new tools are extremely light in weight ranging from 1½ to 2⅞ lb. Numerous attachments can be

SHELL ANNOUNCES NEW TURBINE OIL!



FIRST and ONLY lubricant that meets the most stringent requirements of modern turbine lubrication

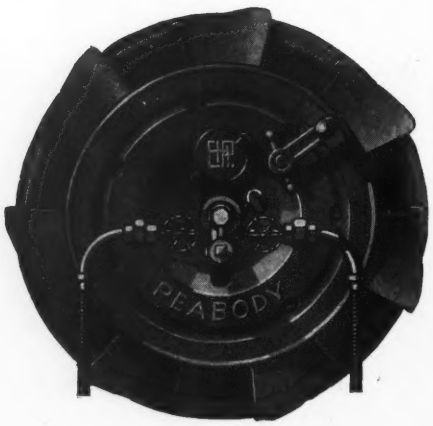
- **RUST PREVENTION**
- **OUTSTANDING OXIDATION STABILITY**
- **NO FOAMING**

No other oil on the market today can match the performance of this new product

EVIDENCE: — Test strips showing that Shell Turbo Oil positively prevents rusting. These four steel strips were immersed for 48 hours at 167° F. in four well-known turbine oils. Top strip, immersed in Shell Turbo Oil, shows no rust. All other strips badly corroded.

SHELL

SHELL *Turbo Oil*



Doing One Thing Well

The men who design and build PEABODY BURNERS concentrate on burners alone and their application to fuels, loads and operating requirements. For decades they have been doing This One Thing Well—which explains the leadership of Peabody Burners.

Experience and specialized knowledge bring understanding in meeting existing or new conditions. The solution to a problem may rest in a more flexible operating range—or in the manner in which fuel is fired—or in obtaining the proper flame and heat distribution—or the selection of some more suitable material at a vital spot. Concerned only with burners, Peabody men are unhampered in aiming toward perfecting burner design and performance.

Bring your burner requirements to Peabody, whose continued success is entirely dependent upon serving you with complete satisfaction.

PEABODY ENGINEERING CORPORATION
580 FIFTH AVENUE • NEW YORK
OFFICES IN PRINCIPAL CITIES

furnished to adapt these tools for light screw driving, nut running, close-quarter drilling, wire brushing, sanding, etc. Three different types of handles are available; straight, lever throttle, or pistol-grip.

Painter's Aids

IN DESIGNING its new paint tools, Bender Products, Dana Ave., Mastic, N. Y., had four principal objectives to accomplish. These were to insure a better paint job, keep hands clean, keep brush clean, and to prevent paint from running over the sides of the can. The complete set consists of two pieces. One is a combination can and brush holder called Handl-grips, and the other a wiping bar. By means of the holder, the

wet brush is suspended in the can but over the paint, where drops cannot make a mess and waste paint. It is made of spring steel and not only holds the brush but snaps onto the paint can and forms a convenient handle. The wiping bar snaps over the top rim and is used to distribute the paint evenly in the brush making the work smoother and more uniform, and prevents excess wasted paint from drooling over the sides of the can. The sets are available in ½ pint, 1 pint and quart sizes.

Condensers

GRID CONDENSERS, manufactured by D. J. Murray Mfg. Co., Wausau, Wis., are especially adaptable for steam power plants and are available in a wide range of sizes and combinations

Schmidt, Garden & Erikson Chicago Architects and Engineers

The MODEL PLANT ... course has ... equipment

the last word in power plant

The COCHRANE DEAERATOR

THIS strikingly modern plant of the U. S. Tobacco Company, situated on U. S. Route No. 1, just outside Richmond, Va., represents the latest in efficient factory design. Its power plant, too, is naturally the epitome of modern theory and practice . . . its feedwater, therefore, is deaerated by a Cochrane Deaerator. ● Modern boiler plants in increasing numbers are selecting Cochrane equipment for feedwater conditioning. That is because of Cochrane's reputation, for one thing, and also because the Cochrane Deaerator guarantees "zero oxygen"... and lives up to its guarantee.

COCHRANE CORPORATION • 3123 N. 17th ST. • PHILADELPHIA, PA.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

LIGHT
TIGHT
TOUGH
CHEAP

Engineered from the ground up — stripped of unnecessary material and weight — trimmed down to a slim thinness—THINSULITE Furnace Walls are really streamlined.

A complete integral construction combining first grade refractory, ample insulation, and a strong supporting frame, provides a wall that is at once permanent, flexible and heat and air tight.

At the price of ordinary brick you can now have a modern sectionally supported wall—and arch—one that gives you assurance of uninterrupted operation and long life.

THINSULITE is suitable for use in any furnace, on all areas where abrasion, spalling or slagging are not likely. Detred construction is recommended for the heavy-duty areas.

See the heat transfer curves shown in the THINSULITE Catalog sent on request.

Thinsulite
WALLS and ARCHES

M·H·DETRICK COMPANY

140 S. DEARBORN ST., CHICAGO

Reliable Buying Bulletins

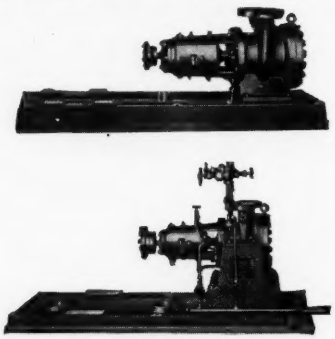
In these pages you will find advertisements of firms that make every type of machinery and equipment for generating, distributing and utilizing power. Their messages constantly record latest progress in power plant equipment. They tell you who makes it, who stands behind it. Consider their advertisements as convenient and reliable buying bulletins.

for installations to maintain the required uniform boiler room temperatures and air movement without stratification.

The condensers are immune to atmospheric corrosion due to contamination of the air from sulphur and sulphides and other products of combustion. No electrolysis can develop in them, as the supply and return lines and the steam chambers are of one type metal, so that only one type metal is in contact with steam, thus preventing electrolytic action. The heating sections of the condensers are easy to keep clean under all atmospheric conditions, as there are no tortuous air steam passages to get plugged up. The condensers are guaranteed for 250 lb. steam pressure.

Pumps

A NEW line of general service Centrifugal Pumps has been announced by the Pacific Pump Works, Huntington Park, Calif. These new Type SV Pumps are designed for all types of service and are able to meet a wide variation in pumping conditions. They can be used both for ordinary general service application and for extremely high temperatures down to sub-zero temperatures, handling both heavy and light liquids. Capacities range from 25 g.p.m. to 1400 g.p.m. against discharge pressures up to 300 lb. Pumps are designed for maximum casing working pressure of 600 lb., and are suitable for handling liquids up to 750 deg. F. at speeds ranging up to 3600 r.p.m.



Pumps supplied for cold service are foot-mounted, as shown in the upper photograph, and pumps for hot service are centerline-mounted, as shown in the lower photograph. The design of these pumps is such that the various parts coming in contact with the liquids or acids being handled can be fabricated of many different types of materials suitable to resist corrosion. They are furnished with vertical suction and discharge openings.

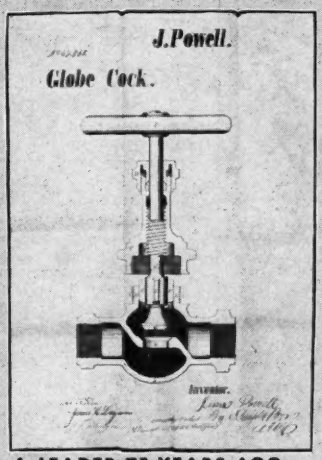
Lamp Guard Socket

SAFEGUARD ELECTRIC CO., INC., Brooklyn, N. Y., has recently announced a new lamp guard with Water-Seeled socket, which has a rubber handle, to which is attached, by means of a rubber locking ring, a rugged metal cage. A Water-Seeled socket is placed within the handle, having a rubber shoulder projecting from the top edge of the rubber handle, to hold the socket so that it cannot come out of the handle.

In assembling the cable to the socket, the joints are first made firm, then soldered, then rubber taped, with excess

1846 ★ 1941

95 YEARS AGO



A LEADER 75 YEARS AGO—

● Cincinnati was a small town, so primitive that its water mains consisted of wooden pipe, with valves made of boards fitted into slides.

On West Fourth Street stood the small home of William Powell, an immigrant to America. He started, in 1846, to make brass castings in the kitchen of his home . . . and it was in this crude "shop" 95 years ago, where William Powell made the first brass faucet west of the Alleghenies . . . in reality his first valve. Little did William Powell know then that *millions* of valves of bronze, iron, and steel were to bear his name in the years to come.

William Powell's youngest son, James, a mechanical-minded lad, helped his father develop a business of making brass castings of various kinds. After his father's death, James Powell carried on. He soon began to take out many patents in the plumbing and power field, one of the first most important being an improved type of Globe Cock (shown on this page) . . . the first successful regrinding principle for valves, which he patented in 1865.

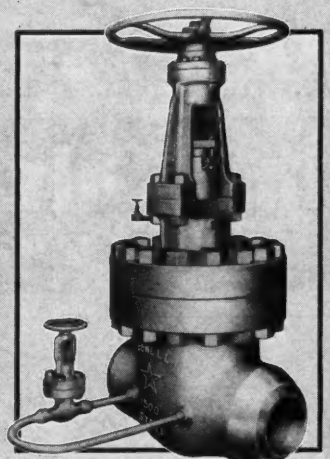
Thus, a valve company began, really, to grow.

And with it, began the demand of industry for more valves, bigger valves, tighter valves, stronger valves. A long cry from William Powell's first brass faucet in 1846 to the Wm. Powell Company's largest steel valve of 1941—from a 6 pound casting to one of 6 tons—from William Powell's kitchen shop and one employee to the plant of today with 600,000 sq. ft. of floor space and many hundreds of employees! But this company has lived and grown these 95 years only because the demand for its product has lived and grown as time marched on.

—AND *Today*

Meantime, today, the valve user in industry is fortunate. The guesswork is taken out of valve buying. The best valve manufacturing plants, today, consist of more than just a foundry and a machine shop. For example, The Wm. Powell Company maintains an engineering department to design the right valve for varying service conditions. It has the most modern chemical and physical testing laboratories for a thorough analysis of raw products and materials. It maintains a rigid testing department for every process of manufacturing and assembling.

For 95 years the Powell "Star" has been the guide to high quality. The years to come will see no dimming of its prestige. The Wm. Powell Company appreciates too well the value of the increasing volume of patronage from an ever growing field to adopt any other creed.



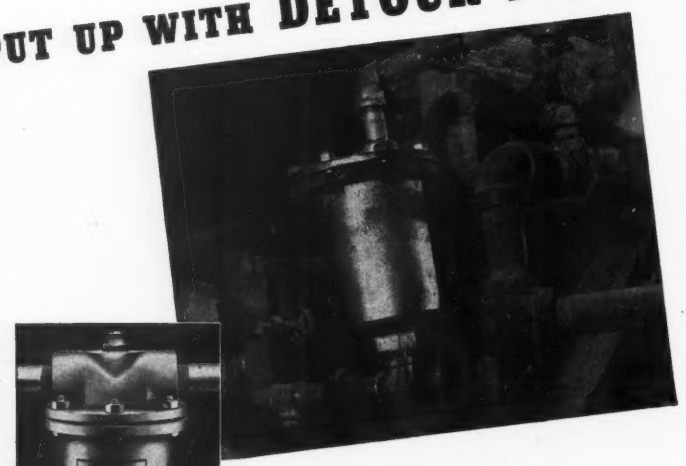
A STREAMLINED 1941 MODEL

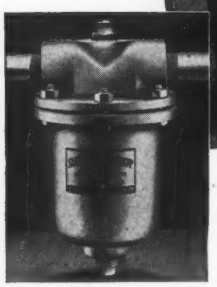
POWELL VALVES

THE WM. POWELL COMPANY • • • CINCINNATI • OHIO

ADVERTISING PAGES REMOVED

WHY DO YOU PUT UP WITH DETOUR PIPING





● Why do you continue to put up with complicated, "detour" piping when simplified piping costs no more, looks neater, saves installation time and gives long service life?

Anderson Super-Silvertop, the inverted bucket trap with simplified piping, is noted for neat, clean-cut installations—straight-in-line piping. It averages more condensate capacity because of larger bucket and longer lever arm. Super-Silvertops are backed by 55 years of steam trap manufacturing experience. Regular inspection is much faster because traps are inspected without disturbing pipe connections. Also, nationwide distribution and experienced field men are assurance of prompt attention and help on trapping problems.

Think about this engineered steam trap—then ask yourself—"Why do I put up with detour piping?" Then decide to do something about it. Send for your copy of "How To Choose A Steam Trap." It's a helpful book of charts, tables and useful information that you can use almost every day. Get your copy and find out more about Anderson Super-Silvertops and simplified piping. Write today.

THE V. D. ANDERSON COMPANY
1939 WEST 96th STREET • CLEVELAND, OHIO

Super-Silvertop
STEAM TRAPS

Let Us Know About It

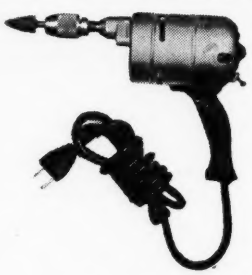
If you have a problem on the installation or operation of power equipment, or if we can be helpful in securing latest catalogs or information from manufacturers, let us know about it. There is no charge for this service. Write Reader Service Department, POWER PLANT ENGINEERING.

tape extending over the cord to form a wedge, which fits into a wedge-shaped slot of the handle when the lamp is pulled through the handle by the cord. The harder the pull, the tighter the wedge binds in the slot, eliminating strain on the joints or socket terminals, which are vulcanized into the rubber socket. This socket which has a rubber lip, seals the bulb at this point. The lamp, being gripped by the lip of the socket, does not back out through vibration.

It is stated that the Safeguard portable, with lamp burning can be completely immersed in water, yet the lamp guard will not be short-circuited nor the operator subject to shock or burn.

Electric Tool

WITH A weight of less than 3½ lb., the new Whiz Electric Tool developed by Paramount Products Co., 545 Fifth Ave., New York, N. Y., makes easy work of drilling holes up to ¼ in. diameter in metal, grinding with wheels up to 4 in. diameter, sharpening all kinds of tools, operating wire brushes, small sanders, polishers, circular saws or performing a host of other tasks around any plant.



Ease of handling is accomplished by making the frame die cast of light weight alloy. The three-jaw, coil spring chuck has ¼-in. capacity, and it is triple geared for extra power. The motor is of the universal type capable of operation on a 110-v. circuit, either a.c. or d.c., and a ball-bearing is well balanced on a pistol grip handle and has a built-in toggle switch easily operated by the hand that holds the tool. Its size is 7⅝ in. by 6 in. permitting its use in close quarters.

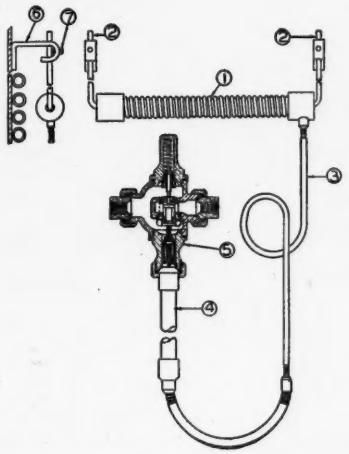
Roofing

ROCAN, a new product in the roofing and building fields, was recently announced by Revere Copper and Brass, Inc., New York, N. Y. Available in standard stock sizes in sheets, rolls and strips which are applied in the same manner as commercial sheet copper. Since the introduction to general use of electrolytically refined copper, sheet metal workers have often claimed that the copper applied to roofs under certain conditions was not as good as "it used to be". Copper companies in the past largely discounted these claims, knowing that the electrolytic process produced a much purer metal than the fire refining methods formerly employed. Revere's research department has found that electrolytic refining removes, along with other impurities, certain elements which tend to prolong the life of copper roofing and sheet metal work. By the re-introduction of some of these minor constituents in controlled amounts, Revere obtains in Rocan a material that forms a better protecting film. This film, being tougher and more tenacious than that formed on ordinary copper, makes Rocan more resistant to corrosion and corrosion fatigue.

Vapor Line Control

SARCO CO., INC., New York, N. Y., has added to its extensive line of self-operated temperature regulators a new instrument known as the Sarco Vapor Line Control, designed specifically to control the heating medium on degreasers.

Degreasers are used in all metal manufacturing and finishing plants to clean screw machine and other metal parts preparatory to plating, or to remove machine lubricants, etc. The parts are cleaned in trichlorethylene vapor or other solvent which is vaporized in the machine by gas or steam heat. It is the function of the new control automatically to maintain the correct vapor line regardless of variations in load and intermittent operation.



This saves solvent, prevents boiling over of the injurious vapors, and further, prevents the formation of rust in the degreaser. The regulator is self-contained and self-operated by the liquid expansion system in which this manufacturer specializes.

Temperature adjustment is made by sliding the bulb 1 up or down in brackets 6 until a position is found for the vapor line in the tank, which maintains the correct boiling temperature (usually 175 deg. F.). Available in sizes ½ to 2 in. for temperature up to 400 deg. F.

Packing

THE B. F. Goodrich Co., Akron, Ohio, announces two new types of packing, one made of Ameripol, its own synthetic rubber developed after 14 years of research and revealed last summer, and the other of Koroseal, a synthetic elastic material. Both are sheet packing.

Ameripol, a dark sheet packing said to be superior to natural rubber and other synthetic packings in its resistance to the action of oils, provides excellent resistance to heat and cold as well as water absorption. Tensile strength is approximately 1,500 lb. psi elongation 400 per cent, shore durometer hardness 78 to 82.

Made to order only in 100 pound rolls, approximately 36 inches wide in thicknesses from 1/32 to ¼ inch inclusive.

Koroseal is specially compounded to resist the action of oils and solvents, and also resists the action of some corrosives. Tensile strength is about 2,200 lb. psi, elongation 300 per cent, shore durometer hardness 73 to 77. It is furnished in 26 by 26 in. sheets, with the 1/32, 1/16, ⅛ and 3/16 in. sheets carried in stock, and other thicknesses made to order.

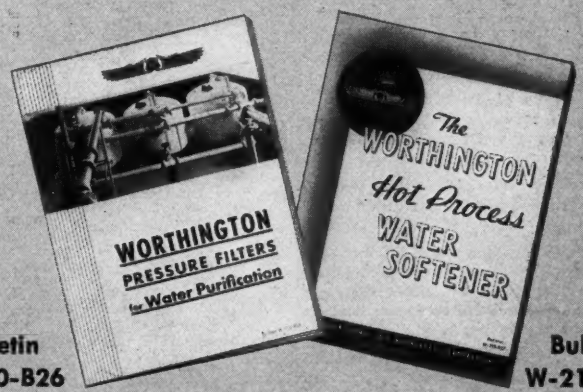
Two Notable Additions to the Worthington Line

HOT PROCESS WATER SOFTENERS and PRESSURE FILTERING EQUIPMENT

Hot Process Water Softening and Pressure Filtering equipment have been built by Worthington for many years in its European plants. Their introduction in this country is therefore based upon long and successful experience and represents the transfer of well established engineering facilities.

Emphasis is placed at this time upon the use of these softening and filtering units for boiler feedwater purification, in conjunction with Worthington feedwater heaters, deaerators, steam condensers, steam turbines, boiler feed pumps, and other power plant equipment.

However, a complete range of types and sizes is offered and their application to other fields will be cultivated. Inquiries covering all classes of service are invited.



Bulletin W-210-B26 **Bulletin W-210-B27**

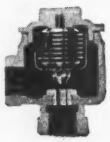
Send for both of these bulletins—they are complete with interesting details.

WORTHINGTON PUMP AND MACHINERY CORPORATION

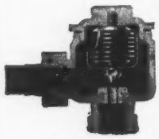
General Offices HARRISON, N. J. • Branch Offices and Representatives in Principal Cities throughout the World

WORTHINGTON

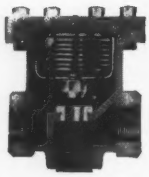
FB1-1



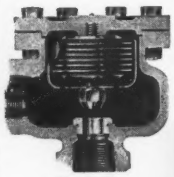
Type A



Type AU



Type B



Type C

Get BETTER DRAINAGE with NICHOLSON Industrial Steam Traps

Better drainage of unit heaters, pipe coils, water heaters, etc., is insured by Nicholson Industrial Steam Trap because of these construction features:

NO AIR-BINDING—All types discharge air just as efficiently as water.

NO FREEZE-UPS—Types A, AU and C drain completely when cold, hence cannot freeze.

NO ADJUSTMENT—Same adjustment used for any pressure from vacuum up to the maximum allowable with construction used.

NO DRIBBLING—Closes immediately when steam contacts bellows.

NO WATER-LOGGED UNITS—Requires but a few degrees temperature differential between steam and condensate to open valve.

Write for Steam Trap Catalog No. 240.

OTHER NICHOLSON PRODUCTS—
Piston and weight operated steam traps, compressed air traps, gasoline traps, steel and stainless steel floats, flexible couplings, 3 and 4-way valves, compression shaft couplings, expanding mandrels, arbor presses, steam eliminators and separators.

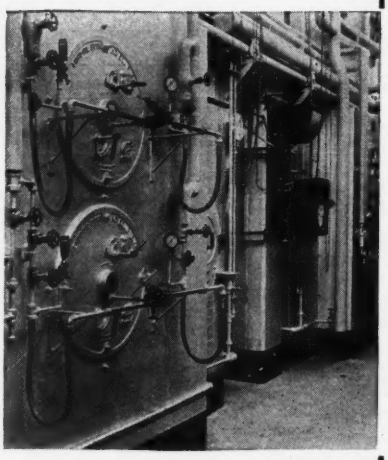
Bulletins on request

W. H. NICHOLSON & CO.
160 Oregon St. Wilkes-Barre, Pa.

Enco Burners

. . . . . for the efficient combustion of all grades of

OIL, TAR or GAS



Burner Units of Steam or Mechanical Atomizing Types in various sizes with capacity ranges of from 1 to 1000 gals. per hour.

Designed for operation either with or without air register for natural or forced draft.

The ENCO Interchangeable Oil Burner is designed for instant change of atomizer gun for operation by either steam or mechanical (pressure) system or to cover a wide range of capacity.

ENCO Oil Atomizers are being applied to various types of standard pulverized coal and gas burner units to provide a dual fuel unit for cold starting or for full load operation when coal or gas is not available or when oil is the more economical fuel.

We have made many installations and would be glad to cooperate with those looking for better operation and assurance against loss of steam output.

Write for Bulletin OB-40 and 37 describing ENCO Oil Burning, Pumping and Heating Equipment.

THE ENGINEER COMPANY
75 West St., New York, N. Y.

Protective Lighting

In planning protective lighting to reduce likelihood of night sabotage in plants working on the defense program, Dudley M. Diggs of G. E. Illuminating Laboratory suggests the folowing: It should be of definite advantage to property protected, any glare being planned to blind an intruder, not a guard; light in a foreground reduces distant vision because of contrast, hence strong light around the boundaries of a property is desirable; background and fences should be as light in color as possible; lighting equipment should be safeguarded from damage.

For use in such systems, a new low-cost, 18-in., 1000 to 1500-watt searchlight is being introduced by G. E. Co. for pilot house or hand control, of aluminum and weatherproof to be mounted on guard house or lookout tower.

Fluorescent Lamp Starter

Hygrade Sylvania Corp., Salem, Mass., announces a new fluorescent lamp starter, Mirastat, availabe in three sizes; No. 2 is designed for use with 15 and 20-watt fluorescent lamps; No. 4 for 30 and 40-watt lamps; and No. 6 for use with 100-watt lamps.

Improvements claimed for this patented starter include elimination of "sputtering," due to proper preheating of lamp cathodes; retardment of blackening at the end of lamps; long lamp life; definite, accurately-timed starting and restarting. Wattage consumed is approximately ¼ watt.

Mirastat is stated to operate with fluorescent lamps on either direct or alternating current, has a condenser designed to minimize radio interference, has compensation for temperature, so that starter operates satisfactorily over a wide range of surrounding temperature conditions, and is interchangeable with glow relay types of starters as it uses the same type of socket.

An addition to the high-nickel alloys group is announced by International Nickel Co., Inc., New York, N. Y., which is "KR" Monel with high yield and tensile strength when worked either hot or cold, corrosion resistant, workable in automatic screw machinery, non-magnetic and can be heat-treated for extra strength and hardness after working. At present it is available only in rod and wire form.

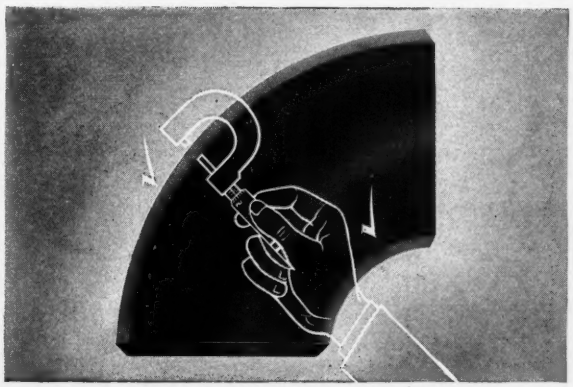
Rubber hose capable of withstanding internal pressures of 15 tons a square inch and more is on the development horizon, according to research engineers of the B. F. Goodrich Co., Akron, Ohio. Principal uses of high pressure hose are in hydraulic control operations, grease and pressure guns, hydraulic riveting machines, and geophysical survey operation in which high pressure hose is utilized to determine the nature of the substrata in the search for oil.

For maintaining constant temperature and humidity in air conditioning, a selector control unit is made by G.E. with synchronous timing motor, relays for handling single-pole, double-throw switching and conveniently located terminals, all in a trimly-finished aluminum case.

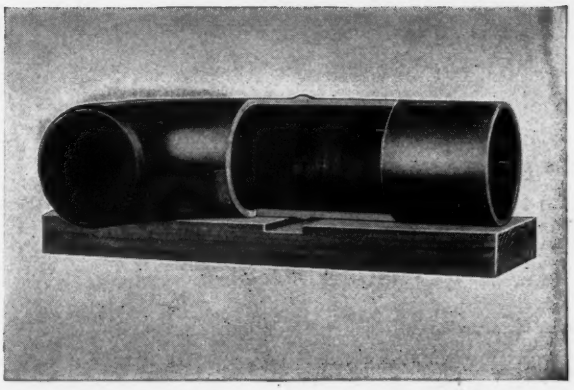
Look at these money-saving reasons

why it pays to insist on

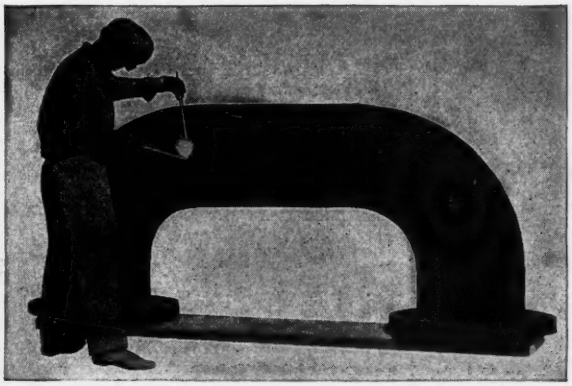
TUBE-TURNS



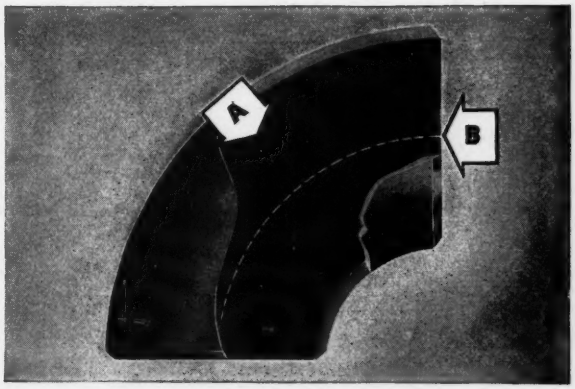
In Tube-Turns seamless welding elbows and returns you get *uniform wall thickness*, within ASTM tolerances, at *all* points —plus improved grain structure with no "locked in" stresses.



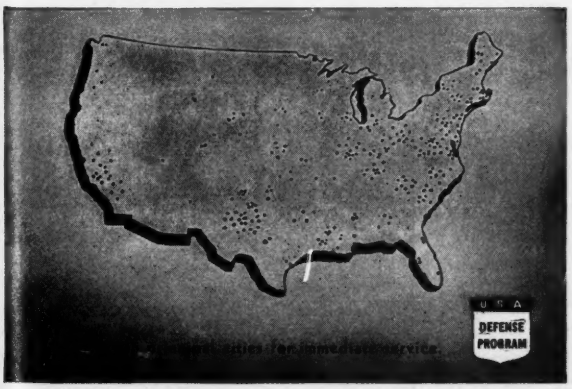
The uniform wall thickness in Tube-Turns permits *exact alignment* with pipe in both O.D. and I.D. (see photo above). This gives you *faster, better* and *more economical welding.*



Tube-Turns are stronger, tighter and lighter. No threads to corrode, no bolts to tighten, no gaskets, no leaks. Tube-Turns cut upkeep expense, are easier to insulate, *yet cost no more.*



(A) Smoother inner walls—with no ridges, waves or scale—mean less corrosion and longer life. (B) Full effective radius insures a *more efficient flow* and *less pressure loss.*

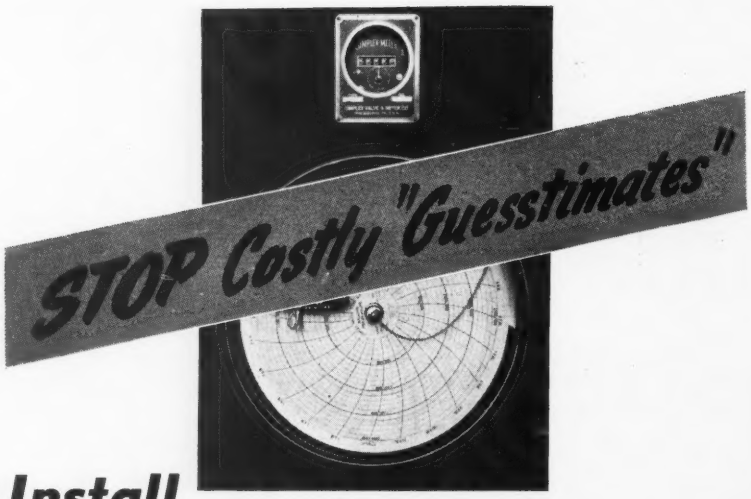


● You'll save money, time and worry by demanding TUBE-TURNS—the *original* seamless welding fittings. You'll get better, quicker service, too. Well stocked distributors in every important city and area—besides ample factory stock—offer immediate delivery. For further facts, or the name of your nearest TUBE-TURNS distributor, get in touch with our closest office shown below!

TUBE-TURNS

90°, 45° and 180° seamless welding fittings, tees, reducers, heads, nipples, laterals, and flanges.

TUBE-TURNS, Inc., LOUISVILLE, KY. ● *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Los Angeles



Install
SIMPLEX METERS

An accurate knowledge of the boiler feedwater consumption, steam flow and other factors relating to boiler performance is essential to economical operation of every steam plant.

Simplex Meters, Type MS, because of their compact form, wider range of applications and lower price, now bring a reliable means of fluid measurement within the reach of all plants.

Let Simplex engineers show you how the proper selection of your metering equipment can insure important plant savings. Write for descriptive bulletin.

SIMPLEX VALVE & METER CO., 6790 Upland St., Philadelphia, Pa.

If You Have a Problem

or if you need information on the construction, use or maintenance of any kind of power equipment, the editorial staff of POWER PLANT ENGINEERING will be glad to help you find a solution or get the desired information. Please give as complete details as possible as to what you want so that the editors may have a clear understanding of your wishes.

Write Reader Service Department, POWER PLANT ENGINEERING.

MANUFACTURERS' NEWS

American Locomotive Co. Promotions

JAMES E. DAVENPORT has been appointed Vice President of Engineering, Development and Research of American Locomotive Co., succeeding Joseph B. Ennis, who becomes senior Vice President.

J. E. Davenport

J. B. Ennis

Mr. Davenport graduated with B.S. in M.E. in 1908 and in E.E. in 1909 from Georgia School of Technology, then was with N. Y. Central R. R. from 1909 to 1940, passing through the shops at West Albany, then to trainmaster, engineer of dynamometer tests, superintendent of fuel and locomotive performance and division superintendent. In 1930 he became assistant to the general manager and progressed to assistant to vice president and assistant chief engineer of motive power and rolling stock.

In 1940 he left the New York Central to become assistant vice president of engineering with American Locomotive Co., his position until the recent promotion.

Mr. Ennis has been in railroading since 1895 with Rogers, Schenectady and American Locomotive works, in the engineering departments, becoming chief mechanical engineer in 1912 and vice president in charge of engineering in 1917. He is also a director of the company.

Clinton D. St. Clair

MANNING, MAXWELL & MOORE, INC., Bridgeport, Conn., has announced the appointment of Clinton D. St. Clair as Works Manager of their Hancock Valve Division Plant in Boston.

He attended Purdue University and Pennsylvania State College. Since then, he has had 22 years of manufacturing experience with such prominent industrial organizations as B. F. Goodrich, Ohio Match Company, Erie City Iron Works, and American Machine & Metals, Inc. His duties for the past 15 years have been similar to those of his present capacity.

FIG. 1501 (*RIGHT*)
CAST STEEL GATE VALVE

•

FIG. 1511 (*BOTTOM*)
CAST STEEL GLOBE VALVE

•

FIG. 1515 (*LEFT*)
CAST STEEL ANGLE VALVE

•

FIG. 1531 (*TOP*)
CAST STEEL CHECK VALVE

READING-PRATT & CADY Helps You Standardize on 150 lb. Steel Valves

When you need valves or fittings for such services as low pressure boiler feed water and steam lines for exhaust steam; and for such auxiliary lines as injector pumps, fans, soot blowers, condensers, heat exchangers, etc., do not fail to get READING-PRATT & CADY'S recommendations.... Our extensive line of 150# Cast Steel Valves and Fittings help you standardize on Steel for 150 lb. Service where conditions such as high temperature make it impractical to use other types of valves. ... Although the valves and fittings illustrated are flanged end, all are available with welding end and most with screwed end. ... Write us for any details on which you wish information.

READING-PRATT & CADY
READING, PENNSYLVANIA

R
READING
CAST STEEL
VALVES & FITTINGS

P&C
PRATT & CADY
BRASS & IRON VALVES

D'ESTE
VALVE AND
ENGINEERING
SPECIALTIES

A Division of AMERICAN CHAIN & CABLE COMPANY, INC.

GREATER BOILER ROOM ECONOMY

with COCHRANE Multiport Relief Valve

WILL NOT STICK, JAM OR FREEZE

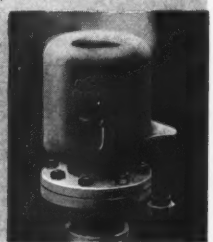
Cochrane Motor Operated Multiport Back Pressure Relief Valve with Automatic Control

The economy of being able to adjust pressure easily according to heating demands is readily apparent—particularly in changing from load periods to off-load, and vice versa.

Cochrane Multiport Back Pressure Relief Valve makes this a very simple operation, either by hand wheel, chain wheel, or automatic control—besides giving you the added protection of its multiport principle, insuring against over pressure and sticking, jamming, or freezing of the valve disc.

Successful operation in more than 12,000 steam plants is ample proof of their reliability. Call your Cochrane representative or write for further details.

COCHRANE Exhaust Head



Designed to separate condensate and oil from steam discharged to atmosphere and thereby prevent raining of water and oily condensate on the roof, Cochrane Exhaust Heads incorporate a highly efficient free-flowing baffle type construction and an exceptionally large port area which minimizes back pressure. Write for further details.

COCHRANE CORPORATION
3123 N. 17th Street, Philadelphia, Pa.

COCHRANE

Cochrane Corp., 3123 N. 17th St., Phila., Pa.
Please send me complete information on Cochrane Multiport Relief Valve and Cochrane Exhaust Head.
Name_____
Firm_____
Address_____
City_____ State_____

George A. Bryant Heads Austin Co.

To SUCCEED the late W. J. Austin, George A. Bryant of Cleveland, executive vice president and general manager of The Austin Company since 1930, has been elected president and general manager.

Mr. Bryant, a native of Chicago, received his engineering education at the University of Illinois and first became associated with The Austin Company as a field engineer 27 years ago. In 1916 he was named district superintendent for all Austin operations in New England, and shortly thereafter became manager of the company's Philadelphia office. In 1918, he was made general sales manager for the entire country, which responsibility he carried until early this year.

As general manager of the company for the past eleven years, Mr. Bryant has had general charge of the design of buildings, making of contracts, securing of materials and field construction operations. In addition, he has been actively interested in the development, through research, of new structural designs and welded construction, and in the application of controlled conditions principles in air-conditioned, windowless buildings now of special importance to defense industries.

A. R. Weis Elected Dresser Director

A. R. WEIS, president and general manager of Pacific Pump Works, of Los Angeles, Cal., a subsidiary of Dresser Mfg. Co. of Bradford, Pa., has been elected to the board of directors of the latter company, as announced by

H. N. M. Mallon, president. Mr. Weis served as vice-president and chief engineer of Pacific Co. from its organization in 1924 until October, 1940, when he became president. He has been identified with development of heavy-duty centrifugal pumps for power plants and oil refineries.

Notice how easily this bottomless Sauerman Bucket rides the coal without "hoeing over" its load.

Power Scrapers for economical coal storage!

● You can increase plant efficiency and reduce coal handling costs to a *few cents per ton* with a Sauerman Power Drag Scraper.

And, in addition to their economy, these speedy machines are simple and automatic in operation, require only one man, and pile coal tightly so as to eliminate spontaneous combustion.

Write for catalog!

SAUERMAN BROS., INC.
486 S. Clinton St. Chicago, Illinois

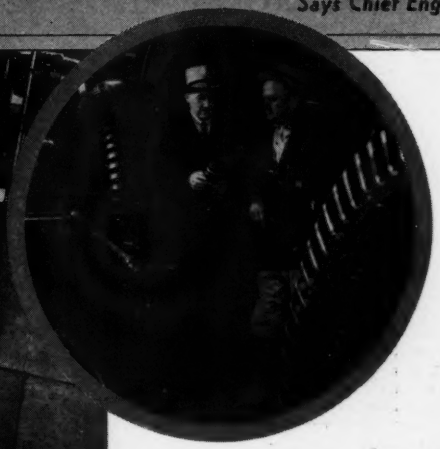
Odd shaped or irregular areas are no problem, can be utilized to the maximum with a Sauerman Scraper.

Guide Posts To Buying

Reading the advertising messages that appear in POWER PLANT ENGINEERING is a profitable habit to acquire. They provide the latest information on what's new and useful in the power plant market. They serve as dependable guide posts to buying.

"GULF PARVIS OIL helps us maintain *Peak Efficiency*"

Says Chief Engineer



"Thanks to the Gulf Engineer, we know how important it is to keep a constant check on lubrication—he has helped us get greater efficiency," *says this Chief Engineer.*

"GULF PERIODIC CONSULTATION SERVICE proved that lower maintenance costs were possible in our plant"

"GULF PARVIS OIL helps to keep our Diesels in perfect operating condition," says this Chief Engineer. "It's the most satisfactory Diesel lubricant we've ever used. Our maintenance costs are lower, and we get better protection for cylinders, bearings, and pistons."

More than 50 leading Diesel manufacturers recommend Gulf Parvis Oil for use in the Diesels they build! Many outstanding records of low-cost Diesel operation are being made with Gulf Parvis Oil. Ask the Gulf Engineer how you can benefit from GULF PERIODIC CONSULTATION SERVICE. Through this practical service plan you can improve the operation of your Diesels and reduce maintenance costs. Write or phone your nearest Gulf office today!

GULF INDUSTRIAL LUBRICATION

This booklet will suggest to you a practical method by which you can improve production and reduce operating costs. Write for your free copy.

Gulf Oil Corporation - Gulf Refining Company
3800 Gulf Building, Pittsburgh, Pa. P.P.E.

Please send me my copy—no charge—of the booklet "GULF PERIODIC CONSULTATION SERVICE."

Name .....

Company .....

Address .....

help WARE HI-LAG Fuses save costly shutdowns

● When you install WARE HI-LAG Renewable Fuses you eliminate delays and expense caused by faulty or inadequate contacts. The WARE improved design, provides SPRING TENSION CONTACTS on both sides of fuse links, which insure greater contact surface and remarkable trouble-free performance.

Another money-saving feature of WARE Fuses is their exceptionally high time lag, which enables them to absorb momentary surges and overloads; this quality further guards against needless shutdowns.

WARE HI-LAG Fuses are fully approved by the Underwriters in all sizes for both 250 and 600 v.; from 3 to 600 amp. The new double-bridge assembly may be inserted either end first.

WARE BROTHERS

4500 W. Lake St., Chicago

Write for TRIAL TEST OFFER, Sizes and Prices

Announcement has been made by Allis-Chalmers Manufacturing Company that Ralph R. Newquist has been appointed manager of the district office at Houston, Tex. Since joining the company in 1934, Mr. Newquist has been stationed in the district offices at Chicago and Pittsburgh, and more recently at Boston.

George B. Kutz, recently appointed District Sales Manager for the southeastern territory of Wright Mfg. Division of American Chain & Cable Co., Inc., York, Pa., was associated with the company for several years as District Sales Manager at Chicago, but more recently he has been located at York, Pa. It is expected that he will make his headquarters in Atlanta, Ga.

Seven new appointments are announced by General Electric: J. J. Curtin transferred from the industrial department is to have charge of magnet wire sales at Ft. Wayne, Ind., replacing B. F. Ilsley who goes to Schenectady as general assistant to W. V. O'Brien in the wire and cable department. O. F. Vea takes over the work of Mr. Curtin. P. A. McTerney appointed manager of sales of large motor and generator division of the industrial department. G. L. Irvine as manager of apparatus agency sales in the industrial department. G. E. Cassidy as engineer of general applications, a new division of industrial engineering. J. S. Overstreet in charge of wire and cable sales at Schenectady.

Defense precautions are being undertaken by Timken Roller Bearing Co. at its plants as there is a large amount of government work being carried on. A 200,000 gal. water tank is under erection as emergency fire supply, and as a reserve for plant supply. Also a fuel oil system with storage for 1,250,000 gal. is under installation to ensure continuous operation in case of failure of the natural gas supply ordinarily used. This provides for a month's operation and is piped to feed open hearth and billet-heating furnaces, and soaking pits. Although fire risk from the oil plant is negligible, as oil has to be heated to 250 deg. F. before it is burned, this plant has a complete fire fighting system with Foamite generators, and dikes around the tanks with capacity 150 per cent of tank capacity.

Elliott Co. of Jeannette, Pa., announces a change of address for its Chicago District Office to Room 2022, 20 No. Wacker Drive.

Green Fuel Economizer Co, Inc., manufacturers of air preheaters, economizers, dust catchers, and mechanical draft fans, announces the removal of its New York Office to 165 Broadway, New York City.

Chelsea Fan & Blower Co., Inc., announces removal to its new plant at Olsen and Grove Sts., Irvington, N. J., in enlarged quarters.

Harry L. Erlicher, starting as messenger boy at 14 yr. of age with General Electric Co. has risen through various promotions in the purchasing department as buyer, assistant purchasing agent and general purchasing agent, and has now been elected as vice president by the board of directors, thus capping 40 yr. of service.

Harry J. Schultz has been appointed Central Regional Manager of the Construction Equipment Division of Worthington Pump and Machinery Corp., with his headquarters at Worthington's Chicago office in the Daily News Building.

Mr. Schultz was formerly manager of the Contractors Division of the Independent Pneumatic Tool Co.

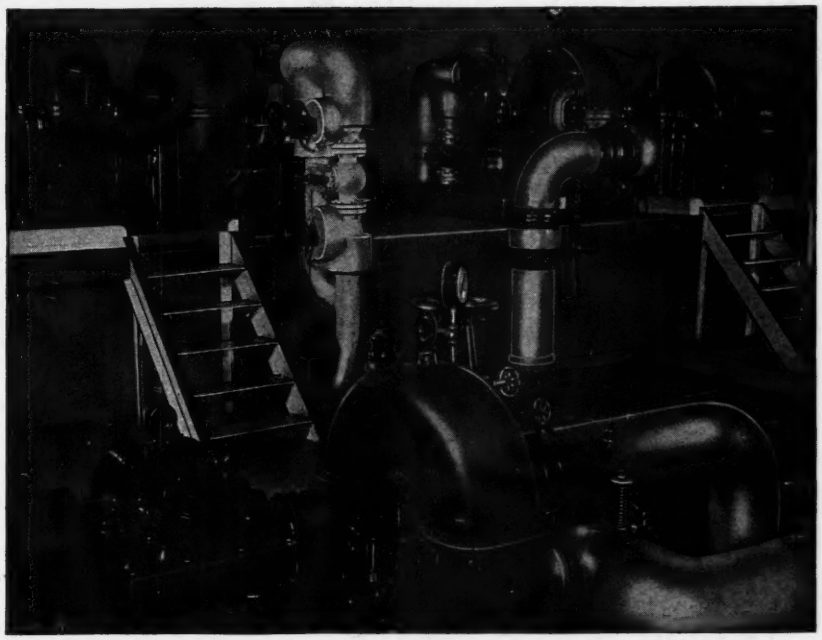
At a special meeting of the Board of Directors of the Joseph Dixon Crucible Co., Jersey City, N. J., held in January for the purpose of filling the vacancy in the Board of Directors and the Presidency due to the death of their honored President, George T. Smith, the following officers were elected: J. H. Schermerhorn, President; E. M. Cabaniss, Vice President in charge of manufacture; L. F. Bruce, Vice President in charge of marketing; H. W. Armstrong, Treasurer and Director; J. P. Templeton, Secretary.

Jack Lewis Minner has been made manager of the fuel oil sales department of Shell Oil Co., Inc., and will be assisted by Colman M. Mockler and Carlyle J. Stockbridge. The New York fuel oil sales department will have complete charge east of the Rocky Mountains of the sales of tractor, diesel, domestic, industrial and bunker fuels, kerosene and also petroleum coke.

G. J. Keady, Executive Vice-President of The Sharples Corp., announces the appointment of John J. Buckley as Works Manager of the Philadelphia plant of the company.

Mr. Buckley was formerly an executive of the Taft Pierce Co. of Woonsocket, R. I., engaged in the manufacture of tools, gages and precision instruments. He is a member of the American Society of Tool Engineers.

TERRY



TERRY SOLID WHEEL TURBINES AGAIN SELECTED BY A LEADING STEEL COMPANY

Shown above are three Terry Turbo-Gear Units installed in a boiler house of one of the country's leading steel producers. These units (plus a fourth not shown) drive draft fans and were placed in service in 1936.

Recently, this company expanded this boiler plant and based upon the superior service that these units have given during the past four years again selected Terry's.

The units all employ the Terry solid wheel which has generous rotor clearances and double rim protected blading. The buckets are milled out of solid metal so that there are no parts to work loose. The entire construction is unusually durable, simple, and fool-proof.

The Terry wheel turbine is fully described in our bulletin S-116. A request on your business letterhead will bring a copy.

Above;
Two 700 HP and one 270 HP Terry Turbines driving draft fans through Terry reduction gears.

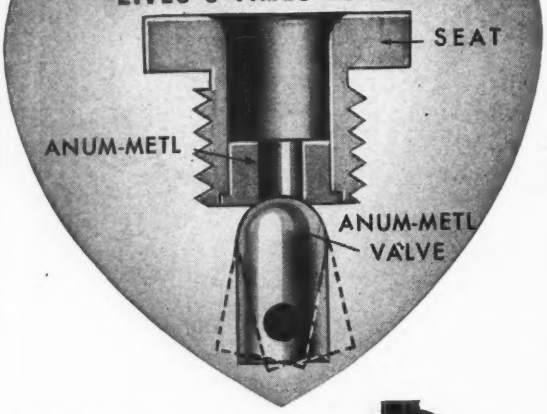
T-1137

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

PIPEWRENCH PETE SAYS:

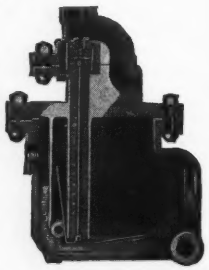
3 OUNCES OF ANUM-METAL CAN SAVE 30,000 POUNDS OF STEAM A MONTH!

"HEART" OF ALL STRONG TRAPS LIVES 8 TIMES LONGER!



STEAM LEAKS COST MONEY!

Diam. of leak	Lbs. steam wasted per 100 lb. press	Cost per mo. at 50c per M lbs.
¼"	203,000	$101.50
⅛"	50,500	25.25
1/16"	12,750	6.38
1/32"	3,175	1.58



"Regular" open Bucket Trap — recommended for any condensate drainage job as "the most economical and dependable trap built."

MAKE THIS *Money-Back* TEST IN YOUR OWN PLANT!

Don't miss this opportunity to test, *in your own plant,* production and steam savings made possible by Strong's amazing ANUM-METL valves and seats!

By actual test, they keep Strong open and inverted bucket traps leakproof 8 times longer than the long-lived metal they replaced. They are *guaranteed* leakproof for one year.

Try the correct Strong traps for 3 months. Then agree they are your best buy *regardless of price,* or return them and get your money back, *plus freight!*

HOW DO YOU SIZE TRAPS? Practical, easy way described in Catalog 63-PE4. Send for it today.

The Strong, Carlisle & Hammond Company
1392 West Third Street, Cleveland, Ohio

STRONG
STEAM TRAPS

Ampco Metal, Inc., Milwaukee, Wis., has shifted the personnel of a number of sales territories. The Michigan territory is being handled by J. K. Bybee, formerly of the Indianapolis office. His headquarters are located at 900 Whitmore Road, Detroit, Mich. E. A. Svobodo of the Chicago office has been transferred to Indianapolis office and is now located at 3330 N. Meridian Avenue.

W. B. McKinzie, recently of the Buffalo office, has been promoted to the Chicago office, while A. J. Reynolds, who previously was an Ampco engineer at Boston, has been transferred also to the Chicago office at 600 S. Michigan Avenue. Boston territory has been taken over by H. R. Gordon, 70 Ionia St., Springfield, Mass., who handles the New England states. Frank P. Gey has been assigned to the Pittsburgh territory, with headquarters at 431 Frick Building.

All of these engineers are thoroughly versed in the application of Ampco Metal and other Ampco-made alloys, and they have been factory-trained in Ampco technique.

Stockholders of American-Marietta Co. on January 24 elected Grove M Hermann, Jr., son of American-Marietta's board chairman and president to the board of directors, while C. S. Beaver, general manager of the company's operations at Marietta, Ohio, and High Point, North Carolina, and Muir Rogers, manager of the midwestern industrial finishes division were elevated to vice-presidencies. Board members who were reelected were G. M. Hermann, chairman, G. A. LaVallee, C. S. Beaver and R. L. Oughton.

George A. Murphy, Jr., has been appointed to the Industrial Sales Division of the American Steel Foundries. Mr. Murphy was educated in Cincinnati, started and acquired his foundry experience under the direction of Dr. Fahrenwald of the Fahralloy Co., and will have his headquarters with American Steel Foundries at East Chicago, Indiana.

M. C. Bellamy, sales engineer of the Seattle Office of The Timken Roller Bearing Co. since 1934, has been made District Manager of Industrial Bearing and Steel Sales for the Seattle territory.

Mr. Bellamy after graduation from Purdue University, spent several years in industrial capacities before joining The Timken Roller Bearing Co. in 1928. After working in the plant and engineering department for two years, he was appointed sales engineer in 1930.

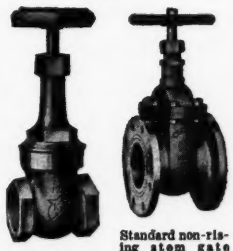
Industrial Unit Heater Association at its annual meeting in Cleveland, Ohio, on January 7, 1941, elected A. B. Donkersley, president; C. C. Cheyney, vice-president and L. O. Monroe, secretary-treasurer. Research on standard methods of testing hot water unit heaters is now underway. Next regular meeting of the Association is to be held at Detroit, Mich, April 17, 1941.

Membership of the board of directors of the Sterling Engine Co. was increased from seven to ten at a stockholders' meeting held on January 23. Addison F. Vars, president, announced that plans are underway for the construction of additional assembly facilities of 100,000 sq. ft., a step made necessary because of the steadily increasing demand for Sterling engines of all models, both for National Defense and for private marine and industrial use. The new members of the board are Lawrence D. Bell, president of the Bell Aircraft Corp.; William J. Conners, president and publisher of the Buffalo Courier-Express; and Reginald B. Taylor, Buffalo financier and industrialist. Other members of the Sterling Engine Company's board of directors are Spencer H Logan, chairman; Charles A. Criqui, vice chairman; Addison F. Vars; Edward H. Townsend, executive vice president and treasurer; Frank G. Raichle, secretary; also Frank G. Cooban, vice president of the Hewitt Rubber Corp. of Buffalo, and A. K. Barbee, vice president of the Coca Cola Bottling Works of Los Angeles, Calif.

At a recent meeting of directors of the Ludlow Valve Mfg. Co. held recently in New York, Alfred W. Thompson was elected President, Treasurer and General Manager. He succeeds L. W. Houston who was elected Chairman of the Board; Harry Hoffman was elected Vice President; John Ireland, Assistant Secretary and Assistant Treasurer. Robert Bischoff succeeds Joseph H. Egolf, who has retired, as Sales Manager.

When you need Bronze Gate Valves.....

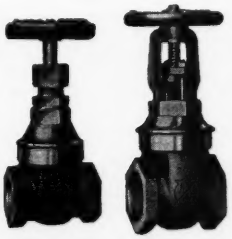
Some of the Kennedy Bronze Gate Valve Types



Standard rising stem gate valve

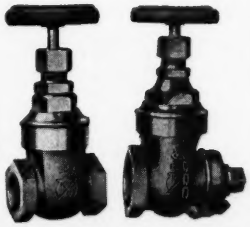
Standard non-rising stem gate valve with flanged ends

Standard gate valve with quick-operating lever



200-lb. non-rising stem gate valve

200-lb. outside-screw-and-yoke gate valve



300-lb. non-rising stem gate valve

Hose gate valve

first see what Kennedy shows in the new Kennedy Catalog

In this 240-page, letter-size cloth-bound catalog you will find a full line of bronze valves in gate, globe, angle and check patterns, for pressures up to 300-lb., and in all standard types and sizes.

For example, the Kennedy gate valves are furnished in non-rising stem, rising stem, and outside screw-and-yoke types, and Kennedy globe and angle valves are supplied with bronze, renewable composition, regrinding, full-way and plug-type discs.

The Kennedy line also includes iron-body valves, malleable-iron and bronze screwed pipe fittings, and cast iron fittings and flanges. Every user of valves and pipe fittings should have a copy of this new catalog—just off the press.

The Kennedy Valve Mfg. Co. Elmira, N. Y.

Send the coupon for your copy

The Kennedy Valve Mfg. Co., 1820 E. Water St., Elmira, N. Y.
Please send copy of your new 240-page catalog.

Name .....

Position .....

Company .....

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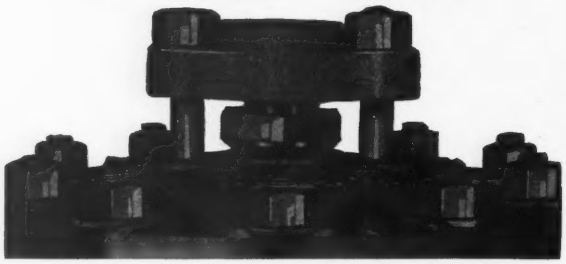
KENNEDY

Extra Values in VALVES and PIPE FITTINGS

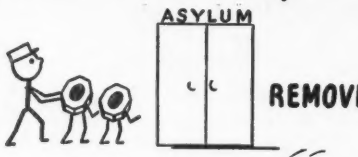
K-MASTER

Modernized

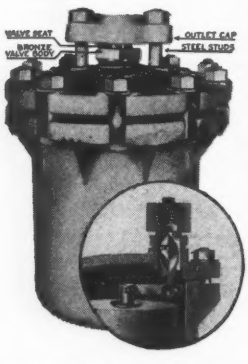
INVERTED BUCKET STEAM TRAP



Match This for Simplicity of Inspection and Replacement



That "in a nutshell" is all there is to getting at the valve, valve assembly, and bucket suspension of the K-Master Inverted Bucket Steam Trap. No need to remove the whole cover.



Such ease of inspection and replacement of parts comes in mighty handy when these steps have to be taken—*as is necessary with all traps.* Remember, too, that the K-Master Trap Valve and Seat are reversible, thus giving extra long life.

Use K-Masters and you'll get better trapping at less over-all cost. Write for catalogue.

KAYE & MacDONALD, Inc.

92 Franklin Ave.
West Orange, N. J.

THOUSANDS OF K-MASTERS IN HUNDREDS OF PLANTS

NEWS FROM THE FIELD

Fred R. Davis

FRED R. DAVIS, a founder of the Audit Bureau of Circulations and advertising space buyer for the General Electric Company at Schenectady for 35 years, died Dec. 26 at his home in Schenectady after an illness of two years. He was 64 years old. For many years he supervised the expenditure of more than a million dollars annually for newspaper and magazine space.

A man of scientific training, Mr. Davis was a pioneer advocate of accurate measurement in advertising and helped found the Audit Bureau of Circulations in 1914. He served as a director from that date until his death and since 1927 had also been first vice president of the organization.

Mr. Davis was born in Adams, Mass., attended Union College in Schenectady, and was graduated from Worcester Polytechnic in 1900 with the degrees of B S. and M.S. in engineering. In 1901, he entered the G-E organization as a test student and in 1902 went to Fort Wayne, Ind., as publicity manager of the Fort Wayne Electric Company. In 1905 he joined the G-E advertising department in Schenectady.

He was an elder of the First Presbyterian Church of Schenectady, a member of the Technical Publicity Association, and a member of the Phi Gamma Delta fraternity.

George T. Smith

AFTER A brief illness, George T. Smith, president of the Joseph Dixon Crucible Co. since 1908, died December 20 at his home, 2652 Hudson Boulevard, Jersey City, N. J. He was the fourth president of the Dixon Co. in its business life of 113 yr. Mr. Smith's career extended over 68 yr. and led him into railroading, banking, government and industry. He was 85 yr. old.

Although born in New York, Mr. Smith spent most of his life in New Jersey. At the age of 17 he entered the employ of the Pennsylvania Railroad, working his wav up to the position of general agent in New York. In 1908 he resigned to become president of the First National Bank of Jersey City, a position which he held until 1916 when he became president of the Title Guarantee and Trust Co. In 1926 he became Chairman of the Board.

Mr. Smith also served in 1895 as a lay judge of New Jersey's highest tribunal, the Court of Errors and Appeals. In 1901 he made his only campaign for elective office, opposing Mark M. Fagan for Mayor of Jersey City. As treasurer of the United States Shipping Board Mr. Smith served throughout the war years until March, 1919.

At his death Mr. Smith, in addition to his presidency of the Joseph Dixon Crucible Co., was president of the American Graphite Co., vice president of the Colonial Life Insurance Co. of America and vice president of the Raritan River Railroad.

Frank X. Pund, Vice President of the D. T. Williams Valve Co., died on January 21st in Cincinnati.

J. W. Gardner

AS A SYMBOL of his 60 years of service with the Gardner-Denver Governor Co., J. W. Gardner, Chairman of the Executive Committee of the Board of Directors of the Gardner-Denver Co. at present wears on his watch chain a tiny gold, diamond-set model of a steam governor.

This token was recently presented to Mr. Gardner by his associates. Mr. Gardner first joined his company as a boy of 17, as an apprentice machinist. His service includes nearly 30 years as President. The 60th anniversary of Mr. Gardner's service follows by little more than a week the recently announced expansion of the company through the purchase of a 13-acre plant near the main plant of the Gardner-Denver Company in Quincy.

To users of

CENTRIFUGAL BLOWERS and COMPRESSORS

You will find in this BOOK useful and reliable information on:

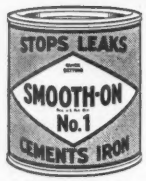
1 — Construction of centrifugal blowers and compressors and their characteristics.
2 — Turbine and motor drives.
3 — Governing.
4 — Properties of gases and the laws governing their compression.
5 — Selecting a compressor for given conditions and calculating the horsepower.
6 — Calculating pressure drop in piping.

Copies will be sent gratis to those stating their business connection. Ask for Catalog F-3816.

DE LAVAL STEAM TURBINE CO., TRENTON, N. J.

Do you know *ALL* the SMOOTH-ON Iron Cements

that can save you time and money on repair and maintenance jobs?



Sold in 1¾-oz., 7-oz., 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

SMOOTH-ON No. 1
Quick-Hardening

SMOOTH-ON No. 2
Slow-Hardening

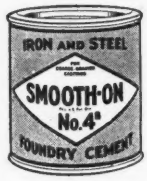
For repairing cracks in boilers, heaters, evaporators, condensers, pumps, and other castings; stopping leaks at pipe connections, bolts, rivets, seams, etc.; and tightening loose parts of apparatus and fixtures.

Sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

Sold in 1-lb., 5-lb. cans; 25-lb. kegs.

SMOOTH-ON No. 3
SMOOTH-ON No. 5

For making up tight screwed, flanged, hub or other types of pipe joints.

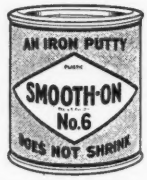


No. 4AA sold in 1-lb. cans; 10-lb., 50-lb. kegs. Nos. 4A and 4B sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

Sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

SMOOTH-ON No. 4

For truing up contours of castings and correcting surface blemishes. Selection of four grades to permit matching the color and grain of any iron or steel casting. Also foundry cements for brass, bronze and aluminum castings.



Sold in 1-lb., 5-lb. cans; 25-lb. kegs.

SMOOTH-ON No. 6

For making watertight joints at roof flashings, glass frames, foundation and window joints, filling in seams and rivet heads.

Sold in 1-lb., 5-lb. cans; 25-lb., 100-lb. kegs.

SMOOTH-ON No. 7

For waterproofing walls and interiors of tanks and cisterns from the inside; for making hard, dustproof and oilproof concrete floors; and for repairing ruts, holes, and cracks in concrete floors.

Smooth-On compositions are obtainable from your dealer or, if necessary, from us. For your protection, insist on Smooth-On, used by engineers and mechanics since 1895.

FREE 40-PAGE HANDBOOK
if you send us your name and address on a post card

The many ways in which these Smooth-On compositions can make your emergency repair and routine emergency jobs easier and more economical are described in this concise handy manual which every engineer should have. Send for your free copy TODAY.

SMOOTH-ON MFG. CO., Dept. 31
570 Communipaw Ave., Jersey City, N. J.

Do it with **SMOOTH-ON**

Standard G & E System

PUBLIC UTILITY operating companies in the Standard Gas & Electric system have a preliminary and tentative construction budget for 1941 amounting to $53,807,229, which includes $23,702,052, carried over from the system's 1940 construction budget for projects not completed during that year. Estimated expenditures in the electric departments of the operating companies in the system total $46,119,541; gas departments, $4,367,156; and other departments, $3,320,532. There is also the possibility of further additions to the 1941 budget which would increase it to approximately $60,000,000.

Included in the preliminary budget are eight major projects which, when completed, will provide additional capacity to the Standard Gas & Electric system of approximately 328,000 kw. giving a total system capacity of 1,731,000 kw. The principal projects consist of the following:

Duquesne Light Co.—completion of a 60,000 kw. unit in the James H. Reed Station at Pittsburgh, authorized in the 1940 budget and scheduled for completion in July, 1941; also a new 60,000 kw. station at Wireton, scheduled for completion in the early fall of 1942. Louisville Gas & Elec. Co., completion of a 25,000 kw. addition to the Canal Station, authorized in the 1940 budget and scheduled for completion in October, 1941. Northern States Power Co. (Minn.), completion of a 50,000 kw. addition to High Bridge Station in St. Paul, included in the 1940 construction budget and scheduled for completion in October, 1941.

San Diego Gas & Electric Co., an additional boiler to be installed in Station B at San Diego, to increase the capacity of that station by 15,000 kw., included in the 1940 budget and scheduled for completion in September, 1941, also a new 35,000 kw. station to be known as the Silver Gate Station, located in San Diego and scheduled for completion in September, 1942. Southern Colorado Power Co., completion of a 7.500 kw. addition to the Pueblo Station, authorized in the 1940 budget and scheduled for completion in May, 1941. Wisconsin Public Service Corp., an addition of 25,000 kw. at Bayside Station in Green Bay, scheduled for completion in June, 1942.

New Navy Ordnance Plant

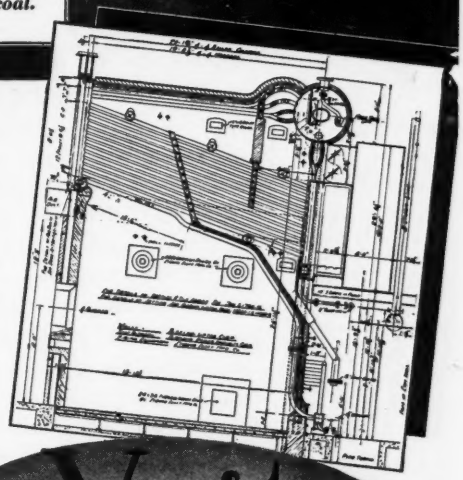
AWARD OF the general contract to construct four major buildings of the new $5,000,000 Navy Ordnance Plant near Louisville, Ky., was announced by F. D. Newbury, manager of the Emergency Products Div., Westinghouse Electric & Manufacturing Co., selected by the Navy to build and operate the plant under a leasing arrangement. Grading and foundation work at the 135-a. Louisville site will start within a few weeks. Structural steel work is expected to get under way in the spring, with completion of the buildings scheduled for July. General contract for the manufacturing buildings, the heating plant and service building has been let by Westinghouse to the J. G. White Eng. Corp.

The new plant will employ approximately 1,000 skilled workers and will operate principally as an assembly unit, receiving parts from other ordnance plants and manufacturers. As announced by the Navy Department, the list of products will include mounts, turret items, gun slides, recoil mechanisms, breech housings and breech blocks. Many of the parts received at the Louisville plant will be manufactured at a $16,000,000 Ordnance Plant which Westinghouse will construct and operate for the Navy at Canton, O. Preliminary work has been started on the site. The Canton operation will include about the same number and types of buildings as the Louisville plant but will use considerably more machine tools and employ approximately 2,000 skilled workers.

Mr. Newbury also announced that A. P. Craig has been appointed executive assistant in the Emergency Products Division, in charge of construction of the ordnance plants, and H. A. Sauerbrey has been named construction engineer, reporting to Mr. Craig. The Westinghouse Construction Department under G. H. A. Parkman will assist and advise the Emergency Products Division in this special construction job. L. D. Rigdon, the Division's manager of manufacturing, disclosed that J. R. Weaver has been appointed manager of the Louisville plant and R. V. Gavert, manager of the Canton plant.

Requirements of the Hagan Corp. to meet demands for industrial and water treatment chemicals have greatly increased due to construction of plants for the defense program. To take care of these requirements, which include those of Calgon, Inc., Hall Laboratories, Inc., and Buromin Co., a new attractive plant is planned to be erected in Baldwin township, Pa., near Pleasant Hills on an 80-acre tract, at a cost of several hundred thousand dollars. First construction will be a production plant, to be followed by an office building and later by a laboratory, the first phase to be started during 1941.

Two 559 H. P. Vogt Sectional Header Boiler units set in battery • Water cooled bridge walls • 180 pounds per square inch design pressure • Air-cooled setting walls and furnace floors • Fuel-Pulverized coal.

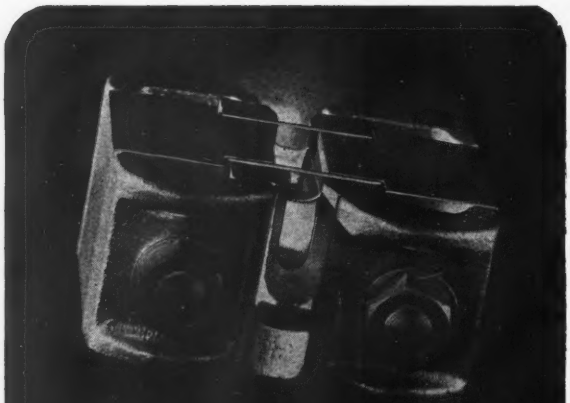


VOGT *Forged Steel* SECTIONAL HEADER BOILERS keep steam costs DOWN and product quality UP!

That "plus value" found in Brown & Williamson tobacco products is made possible through savings which result from lowest processing costs—a tribute to progressive management and a modernly equipped plant. The importance of low-cost steam generation as a factor in keeping down overhead has not been overlooked. That is why Brown & Williamson's recently completed boiler plant modernization program included the installation of two VOGT Sectional Header Boiler units.

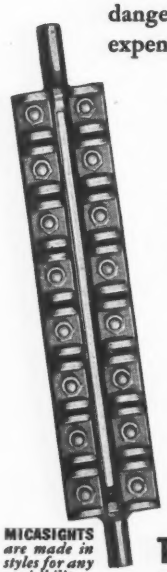
Vogt
Forged Steel
SECTIONAL HEADER BOILERS

HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY.
BRANCH OFFICES: NEW YORK - PHILADELPHIA - CLEVELAND - CHICAGO - CINCINNATI - ST. LOUIS - DALLAS



New Water Gage Safety
• with *Unbreakable* •
MICASIGHT INSERTS

YOUR high pressure boilers need this pressure-defying MICASIGHT to make safe the important job of watching water levels. You're money ahead when you remove danger of flying glass — save the bother and expense of constantly renewing gage glasses.



Mica *bends,* but doesn't shatter. Even the thin sheets you see above resist the highest pressure you'll use. The Reliance forged steel body clamps mica securely, leak proof. Easily replaced if dirty after long use. Can be illuminated for bright sharp reading high on the drum.

Micasight Inserts install quickly in your present gage valves or in long-lasting Reliance Forged Steel Valves. Install this praise-winning safety gage as hundreds of progressive engineers have done. . . Write today for MICASIGHT Bulletin.

MICASIGHTS *are made in styles for any visibility measurement*

The Reliance Gauge Column Co.
5902 Carnegie Avenue • Cleveland, Ohio

TRADE MARK REG. IN U.S. PAT. OFF.

Reliance
Boiler Safety Devices since 1884

Charles E. Wilson, president of General Electric Co., in considering the outlook for 1941 states that the chief concern of the company will be to meet every demand placed upon it for men, materials, and facilities needed for national defense, with clear comprehension of the urgency of these needs; and to the extent that it is consistent with the full performance of this first duty, to do its share toward maintaining the supply of goods which will meet the normal needs of the nation, thus adding to wealth and well-being of the country.

It is his belief that these are the 1941 objectives of American business generally, and that American business will wholeheartedly contribute its full share to the preservation and maintenance of our American way of life. For these reasons, it seems certain that most industrial operations during 1941 will be maintained at full present and planned capacity, and that general business activity will surpass, by a substantial margin, that recorded for any previous year in the history of our country.

For the second consecutive month the average daily production of electric energy for public use reached an all-time high of 416,709,000 kw-hr. during November, the Federal Power Commission reported, which was 0.8 per cent more than the average daily production in October and an increase of 9.1 per cent when compared with the same month of the previous year.

The total production of electric energy for public use during November was 12,501,262,000 kw-hr., of which 4,000,150,000 kw-hr, or 32 per cent, were produced by water power.

Reports received during December, 1940, indicated that capacity of generating plants in service in the United States on November 30, 1940, totaled 41,448,699 kw., a net increase of 163,035 kw. over that previously reported in service on October 31.

Electric utility power plants consumed approximately 4,799,987 t. of coal in November, 1940, of which 4,580,461 t. were bituminous and 219,526 t. were anthracite, decreases of 5.2 per cent and 6.3 per cent, respectively, when compared with the preceding month.

Hygrade Sylvania Corporation of Salem, Massachusetts, announces reductions in prices of fluorescent lamps, effective January 1, 1941, averaging 10 to 15 per cent.

Contracts for an addition to their plant and office building have recently been awarded by the Blackmer Pump Co. at Grand Rapids, Mich., according to an announcement by N. J. Harkness, executive vice-president of the company. Mr. Harkness states that this is part of a general program of expansion of manufacturing facilities to accommodate increased business. The contract calls for completion, ready for occupancy by March 1.

Reviewing stoker progress in 1940 and the outlook for 1941, Frank Hoke, president of the Stoker Manufacturers' Association, pointed out that 1940 broke all records for sales, something over 150,000 units being installed of which 95 per cent were of underfeed type. Home and heating plants were 90 per cent of all sales.

Problems ahead are to keep up with progress in bringing the advantages of automatic coal heat to home and small plant owners, to improve design and convenience, to secure preparation of coals so that they will be desirable for these units. To prepare for a still larger increase in 1941, the Association will hold its meeting earlier in the year than usual, at which time sales programs and plans will be discussed with sales and distributing organizations.

The Amthor Testing Instrument Co., Inc., has recently purchased its own two-story factory building and is now located at 45-53 Van Sinderen Avenue, Brooklyn, N. Y., where larger and finer facilities are available.

Oil Burner Institute will hold a convention in Philadelphia, Pa., at Benjamin Franklin Hotel, with an accompanying exhibit, March 17 to 22. Wednesday, March 19, the meetings will be devoted to: Chimneys by M. O. Lum of G.E. Co.; Commercial Standards by R. K. Thulman of F. H. A.; Heating Equipment Tests by R. S. Dill, Nat. Bureau of Standards; Laboratory Methods by C. R. Welborn of Underwriters' Laboratories.

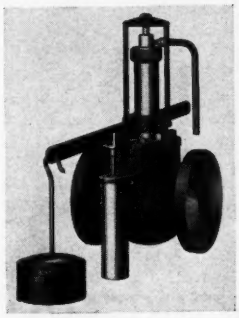
Merchandising will be the subject on Thursday March 20 discussed by W. A. Matheson, asst. to the president Oil-O-Matic Heating Corp.; F. W. Lovejoy, Socony-Vacuum Oil Co.; J. F. Winters, Standard Oil Co. of N. J. Annual banquet and dance will be held in the evening.

Meeting of directors and of members of O.B.I. will be held Mar. 17 and 18 with a dinner Tuesday evening.

FOR MEN WHO WANT TO *SOLVE* PRESSURE REGULATOR PROBLEMS

Left—Davis No. 401 Auxiliary Pilot-Operated Regulator for steam, air, or gas.

Below—Davis No. 15 Pressure Regulator for steam, gas, air, water or oil. Balanced counterweighted diaphragm gives accurate, sensitive control—unaffected by supply pressure variation.



Left — No. 2 Davis Piston Type Regulator for steam, air, and water. Double-seated, balanced piston disc unaffected by pressure fluctuations.

Right—No. 40 Davis Regulator for dead-end service. Self-contained, pilot-operated, spring-loaded.

Above—No. 13 Davis Pressure Regulator for small steam, air, or gas operated equipment. Quality construction and accurate control at a reasonable price.

Above Right—A table of the various sizes and types of Davis Pressure Regulators available as standard stock items. Send for your copy of the complete Davis Regulator Service Chart now!

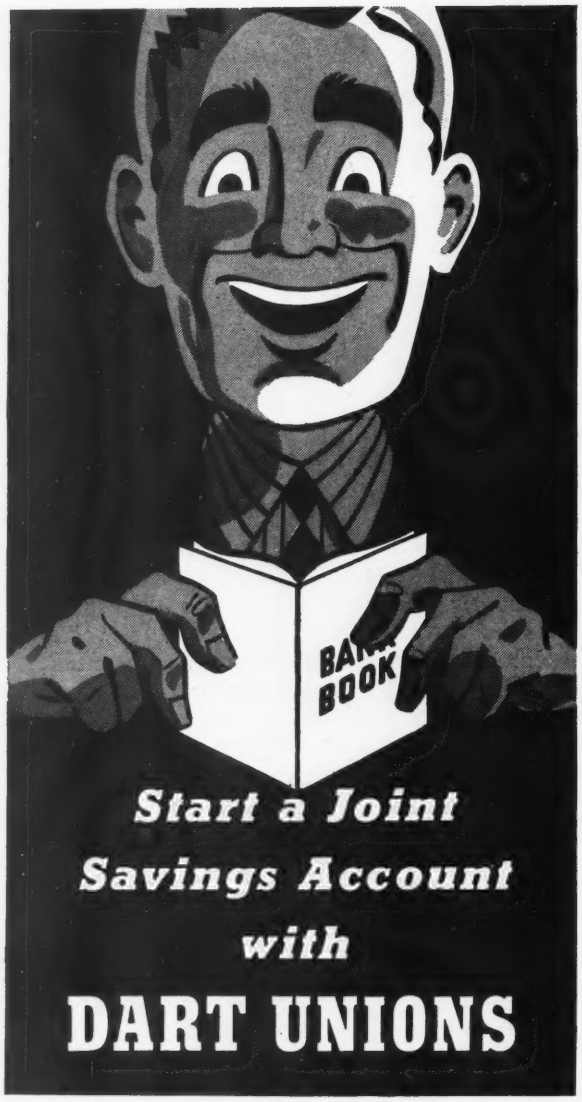
A SOLUTION for any pressure regulation problem can be found in the complete Davis Line. No matter what the pressures involved, the degree of sensitivity needed, the load requirements, or the type of service wanted, there is a Davis Regulator to fit your specifications.

GIVING YOU WHAT YOU NEED IS OUR SPECIALTY! In addition to the complete line of standard units, special units to meet unusual requirements are being built regularly in the Davis plant. Write today for recommendations—no obligation. Catalog on request. DAVIS REGULATOR CO., 2508 S. Washtenaw Ave., Chicago, Ill.

	FOR STEAM, AIR AND GAS *ALSO RECOMMENDED FOR WATER AND OIL													FOR WATER			FOR GAS	
REGULATOR No.	2*	8	13	14*	15	16*	18*	19*	26*	27*	40	49*	408*	17	21	48	9	29
MAXIMUM INITIAL PRESSURE	600	1500	400	400	250	400	250	250	125	125	400	1500	1500	250	125	400	250	250
MINIMUM REDUCED PRESSURE	1	0	½	0	0	0	↑	↑	↑	1	1	0	1	0	½	10	½	¾
MAXIMUM REDUCED PRESSURE	125	300	100	200	30	125	↑	↑	↑	15	300	100	800	100	60	200	100	100
FOR DEAD END SERVICE			✔				✔	✔	✔		✔	✔		✔	✔	✔		
DIAPHRAGM ACTUATED—Direct Acting			✔	✔	✔	✔	✔	✔	✔	✔					✔		✔	✔
PISTON ACTUATED—Direct Acting	✔																	
AUXILIARY PILOT CONTROL		✔																
SPRING LOADED			✔	✔							✔	✔	✔	✔				
WEIGHT LOADED	✔	✔					✔	✔	✔	✔	✔					✔		
SERVICE: GENERAL SERVICE	✔	✔		✔	✔	✔									✔	✔		
SERVICE: LOW PRESSURES—Heating	✔		✔	✔	✔						✔			✔			✔	✔
SERVICE: HEAVY LOAD DEMANDS		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔				✔	✔
SERVICE: SPECIAL SERVICE																		
RANGE OF SIZES	½ to 14	4 to 36	½ to 2	½ to 2½	½ to 14	¾ to 14	½ to 14	½ to 16	½ to 2	¾ to 2	½ to 10	¾ to 14	¾ to 14	2 to 8	½ to 2	2 to 14	½ to 14	½ to 14

DAVIS REGULATOR CO.

PRESSURE REGULATORS • STOP AND CHECK VALVES • LIQUID LEVEL CONTROLLERS • BACK PRESSURE VALVES
STRAINERS • PUMP GOVERNORS • BUTTERFLY VALVES • FLOAT VALVES • RELIEF VALVES • SOLENOID VALVES
MOTOR OPERATED VALVES • NON-RETURN VALVES



The minute you install a Dart, it starts saving money: In the first place it makes up tight quickly, without fuss or jamming. That saves your time. It stays tight in service —prevents leaks, production tie-ups, time out for repairs. And when piping is changed you can re-install Darts over and over, with tight-as-new dependability, and real savings with each re-use . . . Extra heavy bodies and nuts, and bronze seats, ground to Dart's exclusive "true-ball" joint, are the sound, simple reasons for Dart's extra service and savings. Next time, hook-up with Darts.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

United States Civil Service Commission has announced that it will receive applications for positions of metallurgist and metallurgical engineer, various grades, with salaries ranging from $5,600 to $3,200 a year. Salaries for all grades are subject to a 3½ per cent deduction toward a retirement annuity. Qualified persons are asked to send their applications to the Commission's Washington office at once where they will be rated as received until December 31, 1941. Applicants must not have passed their sixtieth birthday on the date of receipt of application.

Applicants will not be given a written test, but will be rated on their educational training and experience. A 4-year college course with major study in chemistry, geology, mining, physics, engineering, or metallurgy is required, plus responsible experience in metallurgy or metallurgical engineering. For the associate grade, appropriate graduate study may be substituted for the entire experience requirement; for the other grades, a partial substitution may be made. In each case, the graduate study must have specific value in the branch of metallurgy or metallurgical engineering in which the applicant wishes to be rated.

For further information regarding the examination and the proper application forms apply to Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the United States Civil Service Commission, Washington, D. C.

Joseph Dixon Crucible Co. has adopted a plan for 1941 under which for each quarter a wage and salary dividend of 6 per cent of earnings will be paid to each employe for each one per cent dividend declared out of current earnings on the company's stock.

Effective immediately, the Grove Regulator Co. announces the expansion of its home office and manufacturing plant, which will be located at 1190 Sixty-Seventh Street, Oakland, Calif.

Employees who have contracts from the government on national defense work are subject to unemployment compensation taxes, the same as if working on private contracts, whether the work be under a bid price, a cost plus percentage or cost plus fixed fee.

FOR THE ENGINEERS LIBRARY

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

METERS AND INSTRUMENTS

Flow Meters—A new 4 pp. 2 color Folder No. 140 on the ADSCO Flow Meter of the orifice type for the accurate metering of steam, water, air or gas has recently been released. It illustrates and describes the construction of the meter which can be supplied with recording chart, indicating scale and integrating counter to totalize the flow or in other combinations of these three devices. American District Steam Co.

Pyrometers—A 28 pp. catalog E-33A-503 lists everything needed to check thermocouple pyrometers. It not only illustrates and describes portable equipment for plant tests under actual operating conditions, but the laboratory apparatus to standardize it Recommendations are also included so that pyrometer users should have little difficulty in choosing checking apparatus best suited to their needs. Leeds & Northrup Co.

Highway To Lower Handling Costs

√ Check these LINK-BELT FEATURES for Efficient Belt Conveyor Operation

LOW COST ROUTE

This modern Link-Belt belt conveyor system, for handling and distributing coal to bins, represents the "last word" in low-cost, high-efficiency conveying. Each conveyor has a capacity of 325 long-tons per hour.

3-roll Anti-Friction Belt Conveyor Troughing Idler and Return Idler.

Positive Self-Aligning Anti-Friction Idler.

√ **1. Anti-Friction Efficiency.** Idlers are fitted with roller bearings which take high radial and thrust loads.

√ **2. Strength and Simplicity.** Riveted idler frames, strong brackets and sturdy rolls make a trouble-free assembly. No bolts or nuts to work loose.

√ **3. Ease of Lubrication.** High-pressure grease system is readily accessible and idler bearings are protected by labyrinth seals which retain grease and keep out dirt.

√ **4. Belt Protection.** Idlers are smooth with rounded edges. Narrow gap between rolls prevents pinching.

√ **5. Accurate, Balanced Rolls.** Accurate machining assures perfect alignment of bearings and uniformity of parts in the complete idlers.

The HEART of the efficient belt conveyor of today is the idler. To this all-important element, Link-Belt engineers have given continuous attention, as a result of which present Link-Belt designs offer the most in dependability and low service cost.

Get information now on better belt conveyor equipment—whether for modernization or new installation needs.

LINK-BELT COMPANY

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Offices, warehouses and distributors in principal cities
Crane-Shovel-Dragline Division—Link-Belt Speeder Corp.
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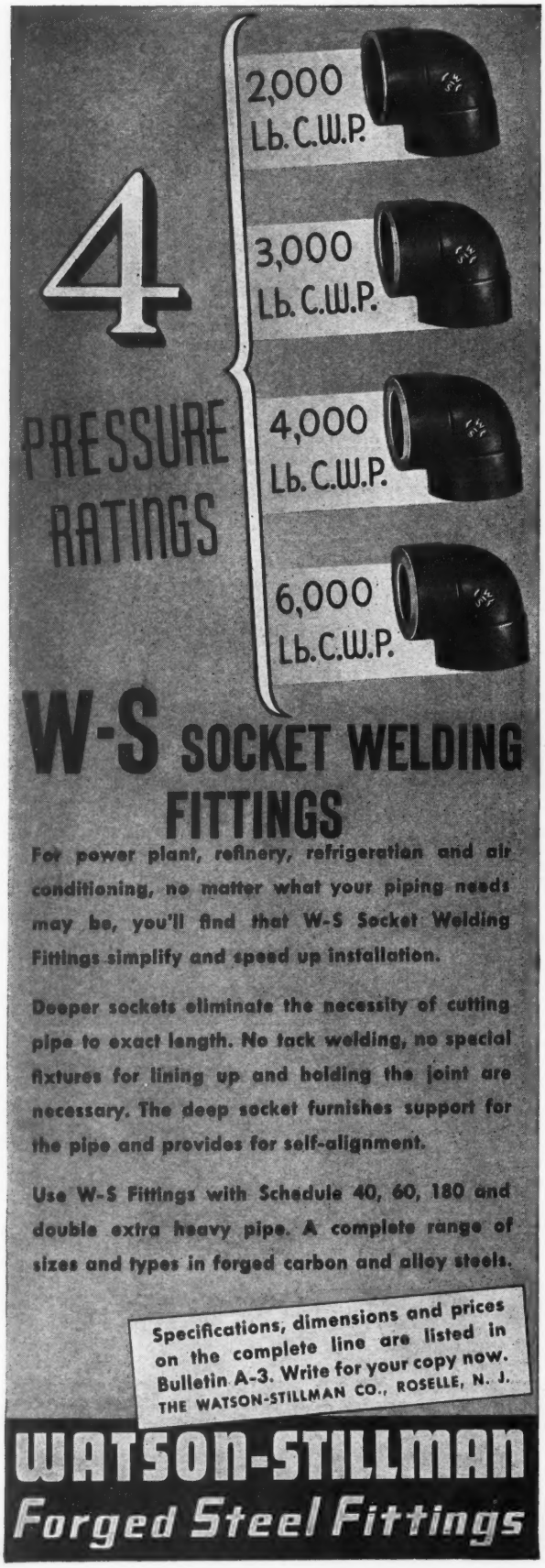
OTHER LINK-BELT EQUIPMENT INCLUDES: Conveyors of all types, such as belt, bucket, screw, flight, drag, chain, apron, etc. . . Bucket Carriers and Elevators . . Skip Hoists . . Feeders of all types . . Weigh Larries . . Coal Crushers . . Water-Intake Screens . . Rotary Railroad Car Dumpers . . Underfeed Screw Type Stokers . . Locomotive and Crawler Cranes . . Roto-Louvre Dryers and Coolers . . Car Spotters and Haulage Systems . . Portable Conveyors and Bucket Loaders . . Silent and Roller Chain Drives . . Speed Reducers . . Variable Speed Transmissions . . Chains and Attachments of all types (Malleable Iron, Promal and Steel) . . Sprockets . . Elevator Buckets . . Gears . . Clutches . . Couplings . . Base Plates . . Take-Ups "Friction Fighter" Self-Aligning Ball and Roller Bearing Units . . Babbitted Bearing Units . . Send for Catalogs.

LINK-BELT

A TYPE FOR EVERY SERVICE

BELT CONVEYOR EQUIPMENT

IDLERS • TRIPPERS • BELTS • PULLEYS • BEARINGS • TAKE-UPS • DRIVES


4
PRESSURE RATINGS
2,000 Lb. C.W.P.
3,000 Lb. C.W.P.
4,000 Lb. C.W.P.
6,000 Lb. C.W.P.
W-S SOCKET WELDING FITTINGS
For power plant, refinery, refrigeration and air conditioning, no matter what your piping needs may be, you'll find that W-S Socket Welding Fittings simplify and speed up installation.
Deeper sockets eliminate the necessity of cutting pipe to exact length. No tack welding, no special fixtures for lining up and holding the joint are necessary. The deep socket furnishes support for the pipe and provides for self-alignment.
Use W-S Fittings with Schedule 40, 60, 180 and double extra heavy pipe. A complete range of sizes and types in forged carbon and alloy steels.
Specifications, dimensions and prices on the complete line are listed in Bulletin A-3. Write for your copy now.
THE WATSON-STILLMAN CO., ROSELLE, N. J.
WATSON-STILLMAN
Forged Steel Fittings

Pyrometers—A new catalog, No. 1104, on potentiometer pyrometers, written in an easily readable style and contains many large illustrations of the interior and exterior of indicating, recording and control pyrometers. Also described and illustrated in this catalog are the Brown Radiamatic Pyrometer, auxiliary switches, control accessories, multiple key switches, thermocouple installations, list of chart and scale ranges and drilling and mounting dimensions. Brown Instrument Co.

Pyrometers—A new catalog, 15-E, on Brown Pyrometers of millivoltmeter type illustrates and describes indicating, recording and control millivoltmeter pyrometers, constructional features and operating advantages. The catalog also contains photographs and description of Brown Diesel Engine pyrometer. Brown Instrument Co.

POWER TRANSMISSION

Controls—A new booklet, No. G-412, entitled How to Speed Up Production with Variable Speed Control, cites 36 specific examples in all types of industrial plants in which speed control made possible definite production increases and advantages. Also fully illustrated and described are the three Reeves speed control units, together with the many different designs and controls available. Reeves Pulley Co.

Gears—Catalog 12-C covers complete data on spur-geared, screw-geared and differential hoist as well as considerable engineering data on cranes, trolleys, and winches. Wright Mfg. Division of the American Chain and Cable Co. Inc.

Bearings—A new 32 pp. catalog, No. 840, entitled Sealmaster Ball Bearing Units illustrates and describes a complete line of advanced designed bearing units, which are pre-lubricated, self-alining and feature the permanent Sealmaster Centrifugal Labyrinth Seal which is said to effectively keep out dirt and retain its lubricant. Shephens-Adamson Mfg. Co.

Belts—A 12 pp. booklet on cord conveyor belt is a recent release describing how the same principle of cord construction used in present day automobile tires to make possible high mileages was made practical by the development of field splicing and vulcanizing. The booklet relates the methods of manufacturing the new type conveyor belt in non-technical language. B. F. Goodrich Co.

Belting—Leather belting and other belt products are described and illustrated in a new 24 pp. catalog. Characteristics of various brands are shown and information given on installation and maintenance of leather belts, with tables on belt speeds, pulley circumferences, and belt lengths. Alexander Brothers.

ELECTRICAL EQUIPMENT

Electricity—A new 24 pp. Bulletin No. 407 entitled Mobile Electricity covers feeders for portable electric tools, cranes, hoists and similar moving loads. Bull Dog Electric Products Co.

Electric Switches and Control—Products for distributing and controlling electric current are featured in a new 92 pp. illustrated catalog covering switches, lighting and fuse panels, circuit breakers, cabinets and Kbl duct. Bull Dog Electric Products Co.

Electric Tools—A new 60 pp. catalog describes and illustrates 132 portable electric tools, including drills, nut runners, hammers, saws, shears, grinders, buffers, sanders and polishers. Black & Decker Mfg. Co.

Switches—Catalog 33582 illustrates and describes 60 amp. and 100 amp. combination switches for two-pole main and range circuits and four one-pole fusible circuits with solderless connectors, reversible bakelite base and tangent knockouts. Square D Co.

Portable Cables—Bulletin 403 describes the use of Trol-E-Duct for wiring feeders for portable electric tools, cranes and hoists. Included with typical installations, are parts, fittings and construction for this Bus-Duct distribution system. Bull Dog Electric Products Co.

Smooth Operator!

IT'S THE OIL THAT DOES IT!

MORSE ROLLER CHAIN Is Channel Lubricated

OIL GETS into the heart of the chain—the pin and bushing surfaces—led there by the channel lubrication system built into every link of interchangeable Morse Roller Chain.

With this positive means for unfailing lubrication, wear stays out! Morse Roller Chain, oiled inside and out, turns tough loads smoothly, quietly, delivering power with continued high efficiency through years of the hardest service. Special steels, precision manufacture, and advanced design work together to make this the finest roller chain available today!

Made in a complete range of sizes, in single and multiple widths. Up to 100 h.p. carried in stocks for immediate delivery at key cities all over the country.

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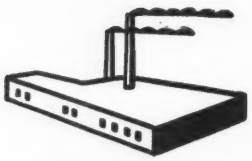
MORSE CHAIN COMPANY ITHACA N. Y. DIVISION BORG-WARNER CORP.



4385 of Americas Leading Plants Now Furnish Their Employees

Formula SBS-II

Each day more and more power and manufacturing plants are specifying FORMULA SBS-11, the modern industrial skin cleanser because:

SBS-11 cleans safely, rapidly, thoroughly.

SBS-11 helps prevent skin irritation, dermatitis and infection.

SBS-11 leaves hands smooth, soft, chap-free.

SBS-11 costs less than 1¢ per worker per week.

Write today for generous FREE TRIAL SUPPLY to Sugar Beet Products Co., 400 Waller Street, Saginaw, Michigan. State number of employees.

Formula SBS-II

THE WASHWORD OF INDUSTRY

Controls—Bulletin GEA-3469, a new 4 pp. release, illustrates and describes a new all-steel enclosed push-button station for standard duty. Included are dimensions, types and markings for typical stations. General Electric Co.

System Analysis—Reprint No. 6, issued November, 1940, by Cornell University is devoted to the subject of Regulating Transformers in Power System Analysis. Copies will be sent free upon request as long as the available supply lasts.

Calculator—A unique, new, convenient Ohm's Law Calculator has been specially designed by the Ohmite Mfg. Co. of Chicago. It gives the answer to any Ohm's Law problem in a jiffy, with one setting of the slide. No decimal points to worry about. All values are direct reading.

The Calculator has scales on both sides so as to cover the range of currents, resistances, wattages and voltages commonly used. It covers the current and wattage range for motors, generators, lamps, electrical apparatus and other applications up to 100 amp. or 1000 watts; also the low current high resistance radio, sound and electronic applications.

The Ohmite Ohm's Law Calculator is available to engineers, laboratory men, production managers, maintenance men, purchasing agents, etc. who write in on company letterhead, giving name and position, to the Ohmite Mfg. Co.

Wiring—Recently announced is a handy, slide type, calculator which is based on the 1940 electrical code to give data for capacities and conduit sizes for various sizes of wire of three grades, also circuit wiring for 3-phase 220 and 440-v. motors of three types. The calculator may be had upon request. Bull Dog Electric Products Co.

Switchgear—G. E. metal-clad gear for voltages to 15 kw. is described and illustrated in a new catalog, GEA-2499A, with examples of installations and details of construction and arrangement. General Electric Co.

COMPRESSORS, TOOLS AND VALVES

Compressors—Recently released catalogs No. L-611-B11S on Single Horizontal Two-stage Compressors; No. L611-B12B on Three-stage Compressors; No. C-1100-B12 on Centrifugal Refrigeration; No. W-103-B4S on Horizontal Duplex Side Pot Pumps and No. H-1200-B12S on Pavement Breakers and Sheeting Drivers are all well illustrated and have technical data on action and use of the equipment. Worthington Pump and Machinery Corp.

Tools—Eight new pneumatic tools, the latest contributions of Thor engineers to industry, are featured in the Thor No. 52 Pneumatic Tool Catalog, 1941 edition. The catalog is fully illustrated by tool and action pictures and gives complete specifications on the entire line of pneumatic tools and accessories. Independent Pneumatic Tool Co.

Valve—A new 2 pp. catalog sheet has recently been released, describing the Vulcalock valve which is suitable for handling corrosive and abrasive fluids under conditions of fairly high pressure, pulsating pressure and throttling or suction. Also included are diagrammatic sketches showing the easily replacable parts together with size data. B. F. Goodrich Co.

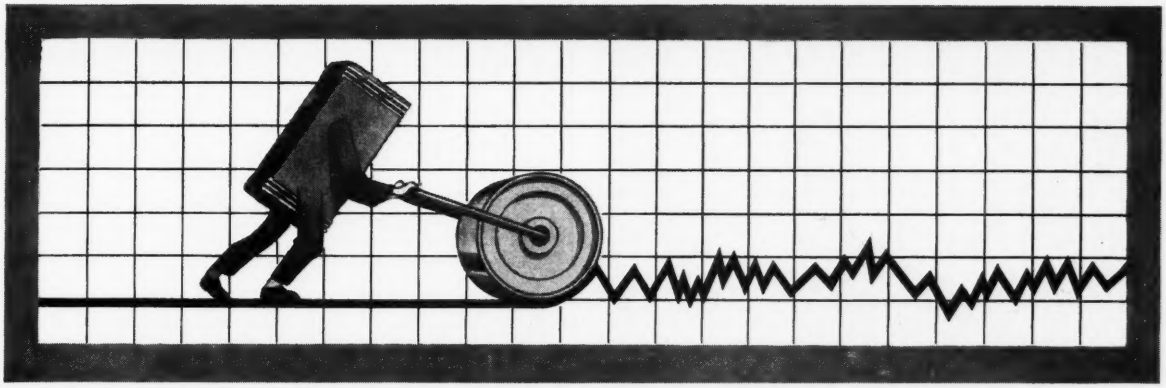
MISCELLANEOUS

Slide Rules—How to Choose a Slide Rule, a 24 pp. illustrated colored humorous publication explains for the first time the difference between the various types of slide rules available, in straightforward, salty language. Although written primarily for students in engineering colleges, this booklet contains slide rule information of interest to the entire engineering profession. Free upon request. Keuffel & Esser Co.

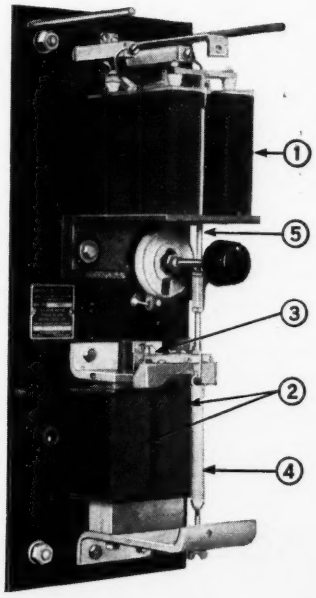
Booklet on the Revere $10,000 prize contest for suggestions on improvement of methods and cutting of costs, by workers in metal industries is now available from Revere Copper and Brass, Inc.

Sliding Grille—Details and hanging of its new grille as used for plants, offices, and warehouses is shown in a new catalog issued by Cornell Iron Works, Inc.

Shaft Seals—A new 20-p. Bulletin 85 describes bellows shaft seals used to prevent leakage of gas or liquids around a rotating shaft. Included are specifications, dimensions and characteristics. Fulton Sylphon Co.



LEVEL OFF YOUR VOLTAGE BUMPS with G-E DIACTOR REGULATORS



Two-stack Diactor generator-voltage regulator, Type GDA, with enclosing case removed. (1) Rheostatic element, (2) D-c coils, (3) Armature, (4) Spring, (5) Lever connecting armature and rheostatic element

The modern, streamlined Diactor regulator is well adapted for semi-flush mounting in your switchboard panel ▶

SMOOTH, steady voltage is easy to obtain with quick-acting, wide-range G-E Diactor generator-voltage regulators. An almost infinite number of smooth resistance steps from practically zero to the maximum produces a correspondingly smooth regulation curve.

These compact little regulators hold the normal voltage close to the desired value quite simply—and without hunting or instability. Any change in a-c voltage causes the armature of a voltage-sensitive torque element (see illustration at left) which is normally balanced, to move against a spring and assume a new position. Thus the armature directly operates the rheostatic element, altering the resistance in the proper direction and amount to correct excitation conditions of the a-c machine and thereby restore the original voltage. That's all there is to it—and the simple, reliable design eliminates troublesome, costly maintenance. One of our specialists will be glad to demonstate how Diactor regulators can solve your voltage problems. Just call the G-E office near you. General Electric, Schenectady, N. Y.

GET THESE ADVANTAGES

Direct Acting— rapid operation

No Vibrating Contacts— reliability and long life

Electrically Damped— no dashpots

All Parts Normally Stationary— no bothersome maintenance

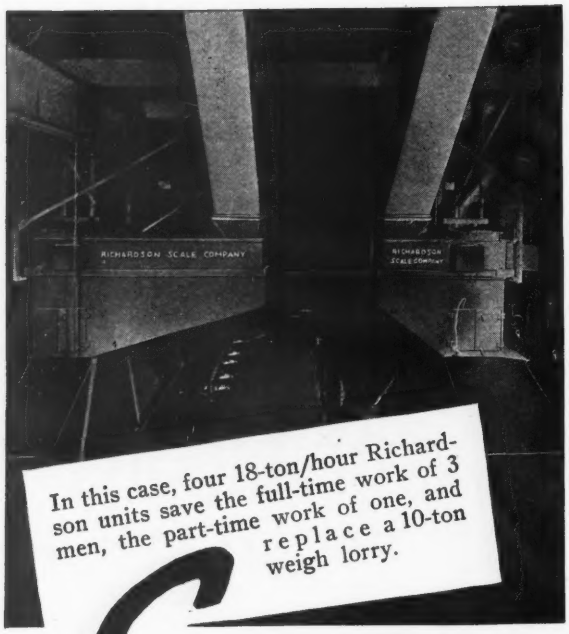
Small, Compact— saves space

Simple Construction— only six leads required

Prices Are Low— Starting at $70 list for the midget of the line

GENERAL ELECTRIC

352-4


In this case, four 18-ton/hour Richardson units save the full-time work of 3 men, the part-time work of one, and replace a 10-ton weigh lorry.

STEP #1

IN ANY MODERNIZATION PROGRAM

RICHARDSON AUTOMATIC COAL SCALES reduce labor and eliminate human error in weighing coal to stokers or pulverizers. That in itself is a substantial saving and an improvement, BUT that is not all . . . for this continuous, automatic weighing puts each boiler under constant test 24 hours a day and thereby quickly makes plain the precise effect of each subsequent step in your modernization program.

RICHARDSON AUTOMATIC COAL SCALES are manufactured with adaptations and sizes that meet individual requirements. Write today for Bulletin No. R6239. It explains clearly and completely the why and how of automatic coal weighing—Step No. 1 in any modernization program.

RICHARDSON SCALE COMPANY
CLIFTON, NEW JERSEY

578

Aluminum—A new 44 pp. catalog, describes many types of aluminum ladders. In addition to the usual broad selection of ladders for fire fighting, industrial and commercial use, the new catalog includes data on aluminum gangways, stages, scaffolding, conveyors and many special aluminum ladders. Also interesting general information relative to the strength, durability and utility of aluminum ladders and gangways. Copy may be had on request on company letterhead. Aluminum Ladder Co.

Metals—Engineering Data Sheets No. 47 and No. 48 make a four-page bulletin covering in detail the correct method for drilling, reaming, milling, and grinding Ampco Metal, a dense, compactly-grained aluminum bronze. Ampco Metal, Inc.

Metallizer Units—A new 4 pp. catalog describes the new Mogul gun which is available in two models, "S" intended for hand operation while model "P" is primarily for lathe tool operation. Both are regulated by a single valve, have a positive wire feed and self-alining bearings. Metallizing Co. of America.

Membership List—Sixth edition of the Directory of Members, their locations and specialties is available from Association of Consulting Chemists and Chemical Engineers, 20 E. 41st St., New York, N. Y.

Condenser Repair—The method of retubing condensers and of stretching tubes whose ends have become affected is described in Bulletin C-41: C & C Corporation.

Oil Heating—Systems for handling oil or other viscous substance which require heating to reduce cost of handling are described in a catalog issued by Albert G. Purdue Associates.

Hose—A new hose catalog divided into three sections covers Hewitt rubber products for the oil marketing industry, the oil producing and refining industries, and for general industry. Hewitt Rubber Corp.

Drainers and Feeders—Direct pressure Liquivators adaptable to drainage of all kinds, boiler feeding and handling industrial liquids for steam, air or gas pressures is available, are described in a new four page folder by the Morehead Mfg. Co.

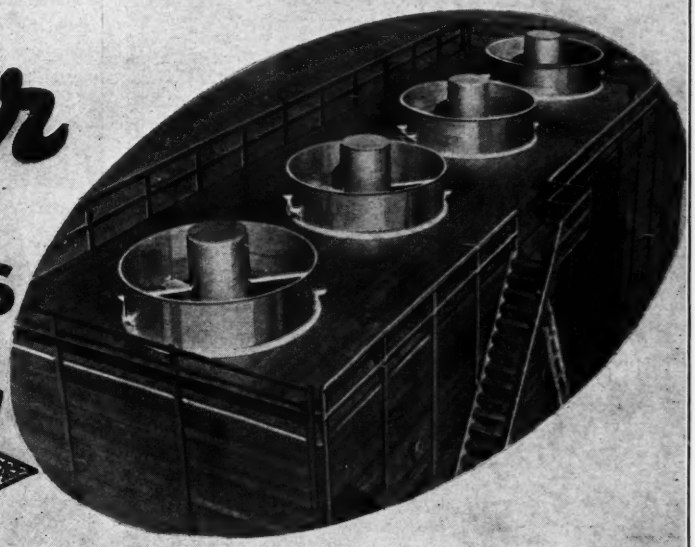
Water Treatment—Standard Methods No. 122 is the title of a discussion issued recently on water conditioning, which contains description and illustrations of equipment for feed water control at constant rate, with metering for constant percentages of treating with dry or liquid chemicals. Proportioneers, Inc.

Spun Concrete Beams

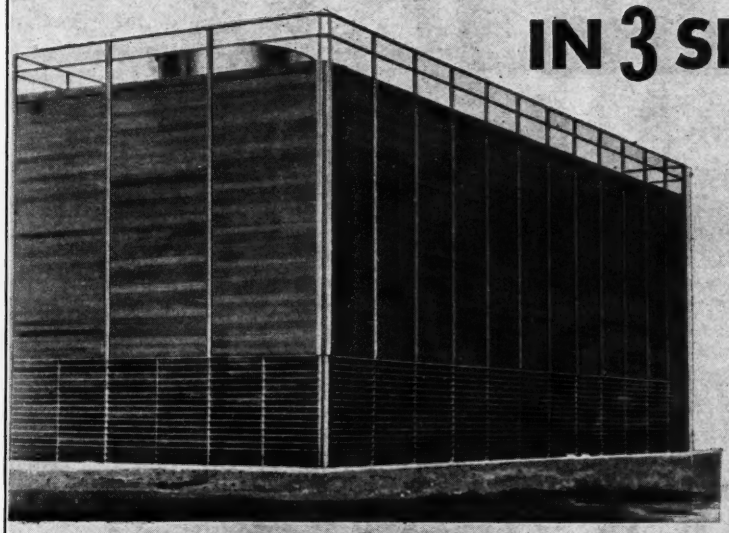
SPUN pipes and poles of concrete, fashioned by revolving rapidly an iron form partly filled with soft concrete have been commonly used. Tests made in Yugoslavia and Czechoslovakia since 1936, and reported in *Engineering* of London show the advantages of similar production of hollow beams in cylindrical and semicylindrical shapes. The exterior of the beams has been made octagonal and semioctagonal; reinforcing rods are imbedded in the concrete.

In beams tested, the inside hole was 8.7 in diameter, and octagonal sides were 11 in. on the flat. For the full octagonal beams, bending stress at breaking was some 50 per cent greater than was indicated by permissible stress in the reinforcement, hence reinforcement could be reduced nearly 45 per cent. By reduction of concrete used and lighter reinforcement, weight of the beams is reduced some 25 per cent.

THE *Tower* THAT SAVES YOU MONEY



IN 3 SPECIFIC WAYS



1. Counter Flow Cooling Efficiency
2. Low Head Pumping Economy
3. Non-corrosive Fans One-half the Usual Weight.

These features are easily recognized as money savers. Counter flow design brings air in where water goes out and results in the coolest air coming in contact with the coldest water.

Low pressure water distribution and low tower height mean correspondingly low pumping head.

Non-corrosive monel fans are one-half usual weight—don't pit—last longer—save power—reduce driving gear wear. An exclusive Pritchard feature. Write for new Bulletin No. 40-A.

J. F. PRITCHARD & COMPANY
Dwight Building Kansas City, Mo.

BRANCH OFFICES IN TULSA, OKLA.; HOUSTON, TEXAS; CHICAGO, ILL.; COLUMBUS, OHIO; ST. LOUIS, MO.

PRITCHARD
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In full octagonal shape, the top of the beam is made flush with the floor surface, ends of the slabs resting on shoulders. For the half octagonal beams, the beams may be placed either side up, the top even with the floor surface. With the concave side down, the openings in the beams and spaces between beams are closed by slabs, giving a level ceiling, also a layer of concrete is placed in the top of the cavity to give the floor an even thickness, since the beam section is comparatively thin. This system is usual for floors. For roofs, with the hollow sides of the beams at the top, the flat surfaces are at roof level and hollow parts of the beams are filled with concrete.

Cost of floors and supports is reduced some 15 per cent. Time of construction is reduced, since it is unnecessary to wait for concrete in each floor to harden.

Dehumidifying Blast Furnace Air

Air conditioning equipment capable of removing from seven to forty tons of water per day from the air blown into one of the world's largest blast furnaces, in order to more closely control the quality of the iron produced, is to be installed on the No. 1 blast furnace at the Aliquippa Works of the Jones & Laughlin Steel Corp., Pittsburgh.

This is the first modern air conditioning unit to be installed in the North for conditioning the air blown into a blast furnace, and will be used to maintain a constant low moisture content in the air blast, eliminating the necessity of trying to outguess the weather 24 hrs. in advance of charging the furnace. With fluctuating moisture content of the atmosphere, operators must constantly change the proportions of raw materials charged into the furnace, which approximate 2000 t. of iron ore, 950 t. of coke, 500 t. of limestone, and 4000 t. of air per day to produce 1000 t. of molten pig iron.

On hot, humid days, more coke must be charged per t. of iron to offset the excess moisture in the air, which is blown into the furnace at the rate of 80,000 cu. ft. per min. This air carries with it into the furnace seven tons of water per day for every grain of moisture content per cu. ft., which has the effect on extreme days of pouring 30 or 40 t. of water into the furnace.

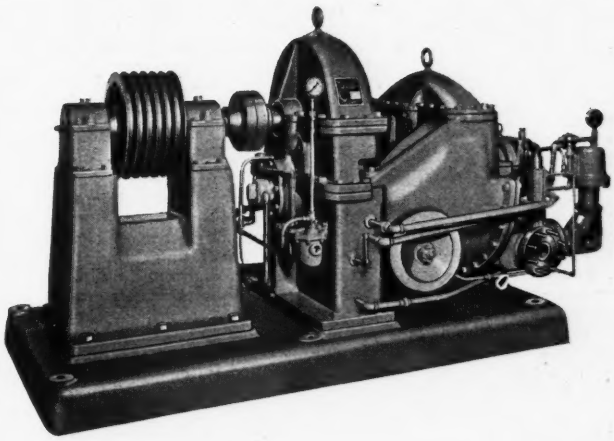
With an air blast of constant humidity, it is possible to control the silicon content and iron temperature within narrow limits, two major factors having a direct bearing on steel quality, so that production of steel by both the Bessemer and open hearth processes can be increased. There is also a possible reduction in the amount of coke and limestone necessary to produce a ton of iron, hence actual increase in iron production may be expected.

Air conditioning equipment, which will be furnished by the Carrier Corporation of Syracuse, N. Y., and installed by the Dravo Corporation of Pittsburgh, conditions the air by drawing it through two chilled water sprays, then passing it through eliminator plates where excess moisture is removed.

MURRAY TYPE "UG" TURBINES

PICTURED here is a 75 hp. MURRAY Type "UG" Turbine adapted for "V" belt drive and using a direct acting variable speed hydraulic governor. This unit is being used in a meat packing plant to drive a reciprocating ammonia compressor.

Our Type "UG" Turbines are adaptable to many purposes and our engineers and representatives will be glad to cooperate with you on your problems.



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Although approximately 1600 so-called business papers are listed in various references, the standards of publishing practice maintained by members of The Associated Business Papers, Inc., are so rigid that less than 200 of this total group qualify for membership. For one thing, qualifying papers must maintain membership in the Audit Bureau of Circulations, whose impartial audits show advertisers exactly how many interested readers, like yourself, voluntarily pay for their business papers. And each A.B.P. publication must be independently operated, editorially unfettered, ethically administered.

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New Engineering Books

Statistical Methods. By George W. Snedecor. Third edition. Published by the Iowa State College Press, Ames, Iowa. Size 6 by 9 in. 414 pp., cloth bound. Price $3.75.

Statistics are playing an increasingly important part in business, engineering, and experimental work of all kinds. Unfortunately, however, the proper interpretation of these statistics, their meaning and use is a specialized job which is understood by only a very few. This book is a detailed manual for those who want to learn to use and be guided by statistical methods in experimental or sampling work. A measure of the effectiveness with which the book has met the need for work of this kind is testified for by the fact that this is the third edition in three years.

In addition to the original material covering experiment, individual comparisons, sampling, group comparisons, short cuts, analysis, etc., the new edition has a number of significant additions. Perhaps the most interesting thing is a new chapter on design and analysis of sampling. This covers sampling from a homogeneous population, size of sample, sampling from small populations, sampling from two or more homogeneous populations, effect of errors, structure of sampling investigations, etc.

While the work can be recommended without reservation, it must be pointed out that it is not a popular treatise but a working guide. As such it is highly mathematical and of service only to those of sufficient mathematical background to follow the calculations. This does not require the knowledge of advance mathematics but it does require a good working knowledge of arithmetic and algebra. The author is director of the Statistical laboratory of Iowa State College.

Elementary Engineering Thermodynamics. By V. W. and G. A. Young. Published by the McGraw-Hill Book Co., Inc., New York, N. Y. Size 6 by 9 in.; 218 pp.; cloth bound. Price $2.75.

In writing this book, the authors, who are respectively Professor of Mechanical Engineering at Oklahoma Agricultural and Mechanical College and Professor and Head of the School of Mechanical Engineering at Purdue University, had in mind a text to cover the theory of heat-work apparatus, that is an introductory course preceding detailed and more specialized instruction in related fields of engineering such as internal-combustion engines, power plant design and testing, refrigeration and air conditioning.

The book is divided into 13 chapters covering thermodynamics laws, principles and application to gases, vapors, cycles, air compression and refrigeration. The last chapter, covering mixtures of air and water vapor, is not usually found in a book of this type and has been included as a thermodynamic foundation for the study of air conditioning processes and apparatus.

While the treatment is brief and uncomplicated, the text is clear, illustrations well selected, with a large number of illustrated problems worked out. In addition, each chapter has a number of suggested problems, an 18 pp. appendix includes tables, the property of common gases and vapor, a temperature entropy chart for steam, a Mollier diagram for steam and a psychrometric chart.

Recovery of Sulphur Dioxide from Dilute Waste Gases by Chemical Regeneration of the Absorbent is a 137 p. paper bound report by H. Fraser Johnstone and Alamjit D. Singh. It is published as Bulletin No. 324 by the Engineering Experiment Station, University of Illinois, Urbana, Ill., and sells for $1.00. A limited number of copies are, however, available for free distribution.

The object of the investigation covered by the report was to study methods of elimination of sulphur dioxide from boiler furnace gases and to develop processes through the pilot plant stage. A fundamental viewpoint of the work was that elimination of sulphur dioxide from these gases required the recovery of the sulphur in some commercial

Quiet
WING TURBINE BLOWERS
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ENGINEER TELEPHONES WITHIN FEW FEET OF TWO LARGE WING TURBINE BLOWERS SERVING TWO STEAM GENERATORS
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form. It is estimated that equipment to treat 100,000 cu. ft. of gas per min., including machinery for liquefaction of the SO_2 would cost approximately $140,000, that the fixed and operating costs would amount to approximately $15.40 per ton of SO_2, or somewhat over $1.00 per ton of coal burned.

Directory of Electric Utilities in the United States, 1940. First Edition, 800 pages, size 6 by 9, semi-flexible blue simulated leather. Published by the Federal Power Commission, Washington, D. C. Price $2.00.

This book the first of its kind published by the Federal Power Commission was compiled by the Commission in collaboration with the Federal Works Agency from data furnished by the entire electrical industry. The new publication makes available for the first time a complete and authoritative list of all publicly and privately owned electric utilities. The following items of information are shown in the Directory for each utility.

1. The name of the utility, its principal business office address, and the State or States in which it operates.
2. The corporate control over the utility. The top holding company and the extent of voting interest if control is direct rather than through subsidiaries, are shown.
3. The names of officers and directors.
4. Companies that are controlled by the utility.
5. Total assets, including assets other than for electric operations.
6. Electric operating revenues.
7. Number of electric customers.
8. Generating capacity.
9. Kilowatt-hours generated and purchased.
10. Communities served at retail.
11. Utilities served at wholesale.
12. Other services rendered.

Every utility that renders electric service in a community of 250 or more population is included in the new volume, as well as establishments which sell electric energy at wholesale to distributing electric utilities.

All information shown in the Directory has been verified by the respective utilities and is, therefore, an authoritative and accurate presentation of the latest available data. Utilities are listed alphabetically within States by class of ownership and those operating in more than one State are listed in each State in which they operate. In such cases, operations within individual States are shown and aggregate operations are presented, together with State data, in the State in which principal operations are conducted.

Two indexes are employed to facilitate the use of the Directory. An index precedes the data for each State, listing alphabetically the utilities operating therein, and in the back of the volume is an alphabetical list of all utilities in the United States, showing the States in which they operate and the page upon which data are presented for each.

The Directory will be sold at $2.00 a copy by the Federal Power Commission only, to which all orders should be addressed, enclosing cash, check or money order. For convenience in ordering, the publication may be referred to as "FPC S-8".

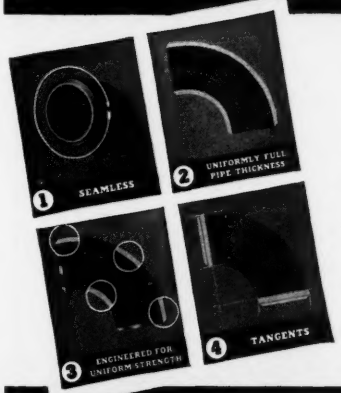
A.S.T.M. Standards on Coal and Coke. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Size 6 by 9 in., 123 pp., paper bound. Price $1.25.

This is a convenient compilation in one book of all the A.S.T.M. tests, definitions and specifications for coal and coke. It covers 28 separate standards, including sampling, coal analysis, classifications according to ash content, sampling and fineness test for powdered coal. grindability tests, procedures for the drop shatter tumbler tests, a proposed test for agglutinating value of coal, classification of coals by rank and grade.

Macquown's Coal Directors and Buyers' Guide, 20th Edition. Published by National Coal Publications, Pittsburgh, Pa. Price unabridged $15. Abridged $10. This is a directory of coal operating and selling companies for the entire country; of pocket size with figures of coal analysis by districts, on which prices are based.

Installation and Maintenance of Electrical Motors. In the Nov. 1940 issue, the publisher of Installation and Maintenance of Electric Motors by E. Molloy was incorrectly given as Chemical Rubber Co., Inc. This should have been Chemical Publishing Co., Inc., 148 Lafayette St., New York, N. Y.

TAYLOR FORGE



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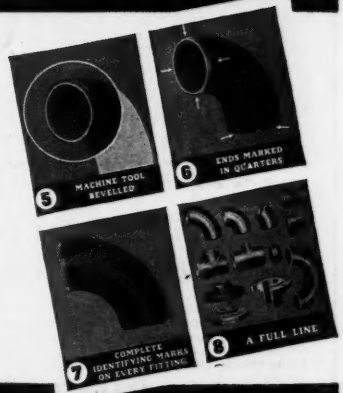

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Power Plant Construction News

Colo., Crested Butte — Gunnison County Rural Electric Association, Crested Butte, care of Rocky Mountain Engineering Co., 1425 Welton Street, Denver, Colo., consulting engineer, plans new electric power plant for service for rural electric lines. Appropriation is being secured through Federal aid. Engineer noted is in charge.

Ga., Macon—Reynolds Corporation, 200 Southern Building, Washington, D. C., plans installation of electric power equipment in new fuse-loading plant near Macon, to be constructed and operated for Federal Government. It will comprise several large production units. A power house is proposed. Entire project will cost about $1,000,000. Work is scheduled to begin at early date.

Ill., Chicago — Wisconsin Steel Works, Inc., 2701 East 106th Street, has approved plans for new multi-story boiler house, 35x50 ft., at plant, and will proceed with erection at once. Cost over $65,000, with boiler units and auxiliary equipment. W. J. Hammer, 3141 South Hoyne Avenue, is engineer. Company also plans installation of electric power equipment in connection with expansion and improvements in mill. Entire project will cost about $1,500,000. This company is a subsidiary of International Harvester Co., 180 North Michigan Avenue, Chicago.

Ill., North Chicago—Fansteel Metallurgical Corporation, 2200 Sheridan Road, manufacturer of special metal products, plans installation of electric power equipment in new one-story addition, 125x150 ft. Entire project is estimated to cost about $175,000.

Ind., Charlestown—Goodyear Engineering Corporation, recently organized subsidiary of Goodyear Tire & Rubber Co., same place, plans installation of power equipment in new powder-bagging plant at Charlestown, to be constructed and operated for Federal Government on cost-plus-fixed-fee basis. A power house will be built. Tract of 3000 acres of land has been acquired for project, on which work will begin soon. Cost estimated close to $13,900,000.

Ind., South Bend—Studebaker Corporation, South Bend, manufacturer of automobiles, plans installation of electric power equipment in new plant on 21-acre tract of land at the terminus of Chippewa Avenue, for production of aircraft engines for War Department. A power house will be built. Entire project will cost over $20,000,000, for which appropriation will be provided by Government. Work will be placed under way soon.

Iowa, Dubuque—Interstate Power Co., plans addition to steam-electric generating station for expansion in steam division, with installation of boiler unit and auxiliary equipment. Estimates of cost are being made. Sargent & Lundy, 140 South Dearborn Street, Chicago, Ill., are consulting engineers.

Ky., Henderson — Solvay Process Co., 40 Rector Street, New York, N. Y., plans installation of electric power equipment in new synthetic ammonia-manufacturing plant at West Henderson, to be operated for production for Federal Government, which has acquired site for project. A power house will be built. New plant is estimated to cost about $11,100,000 and will be constructed and operated by company on cost-plus-fixed-fee basis. Proposed to begin work at early date. Company is a subsidiary of Allied Chemical & Dye Corporation, 60 Broadway, New York.

Md., Baltimore—Cloverland Farms Dairy, Inc., 1900 Windsor Avenue, plans new boiler house at milk products plant. Cost estimated over $30,000, with boilers and auxiliary equipment. L. R. Spelshouse, 1621 Frederick Avenue, is architect.

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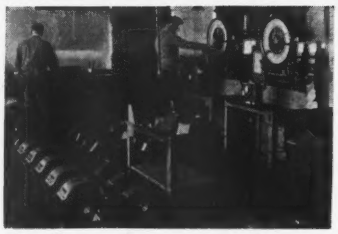

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Box 1207, c/o Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Neb., Kearney—State Board of Control, Capitol Building, Lincoln, Neb., has secured recommendation of State Planning Board for new power plant for central-heating service at State Hospital, Kearney. Cost estimated about $75,000, with equipment. Also, approval for similar power plant at State Industrial School, same place, to cost about $55,000, with equipment. Proposed to carry out projects this year.

Neb., Omaha—Metropolitan Utilities District, Eighteenth and Harney Streets, plans addition to boiler house at municipal gas plant, with installation of two new 250-hp. boilers and auxiliary equipment. Cost estimated over $200 000. Proposed to carry out work in 1941. Walter Byrne is general manager.

N. Y., Cheektowaga—Buffalo Arms Corporation, care of Houde Engineering Co., 537 East Delavan Avenue, Buffalo, N. Y., recently organized as an associated interest, plans installation of electric power equipment in new plant at Cheektowaga, near Buffalo, for production of small fire arms for Government. A power house will be built. Entire project will cost close to $5,000,000. Both companies are subsidiaries of Houdaille-Hershey Corporation, National Bank Building, Detroit, Mich., manufacturer of automobile equipment.

Ohio, Columbus—Curtiss-Wright Corporation, 30 Rockefeller Plaza, New York, N. Y., manufacturer of airplanes and parts, has approved plans for power house at new branch plant at Port Columbus, near Columbus. Also will install electric power equipment in plant, which will consist of two main one-story units, 600x1400 ft., and 100x900 ft., respectively. Work will proceed soon. Albert Kahn Associated Architects & Engineers, New Center Building, Detroit, Mich., is architect and engineer. Entire project will cost close to $7,000,000.

Ohio, Hamilton—City Council is considering extensions and improvements in municipal power plant, including installation of new boiler unit, stokers and auxiliary equipment. Cost estimated close to $500,000. An underground municipal electric distribution system in downtown district also is planned. Froehlich & Emery Engineering Co., Second National Bank Building, Toledo, Ohio, is consulting engineer.

Ohio, Springfield—Ohio Edison Co., Springfield, has approved plans for addition to Gorge steam-electric power plant on Cuyahoga River, with installation of turbine-generator unit, high-pressure boilers and auxiliary equipment. Cost estimated close to $3,500,000. Award for generator has been made to Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and contracts for other equipment will be made at early date.

Ore., Portland—Portland Bottling Works, Inc., 1271 North Williams Avenue, plans installation of electric power equipment in new two-story bottling plant on site at N.E. Thirteenth and Fourteenth Avenues, Couch and Davis Streets. Entire project will cost close to $200,000.

Tenn., Milan—Proctor & Gamble Defense Corporation, Gwynne Building, Cincinnati, Ohio, recently formed as an interest of Proctor & Gamble Co., address noted, plans installation of electric power equipment, in new shell-loading plant at Milan, for operation for War Department, Washington, D. C. A power house will be built. Entire project will cost about $28,000,000, with fund to be arranged by Government. Work is scheduled to begin soon.

Wis., Superior—Superior Water, Light & Power Co., has plans under way for addition to steam-electric generating station on Hughitt Avenue, with installation of turbine-generator unit, boilers and auxiliary equipment for large increase in capacity. Cost estimated close to $1,500,000, with equipment. Proposed to begin work early in summer. Application has been made for permission.

Wyo., Cheyenne—Frontier Refining Co., Second and Duff Streets, plans installation of power equipment in new addition to oil refining plant for production of gasoline, etc. Proposed to install boilers, compressors and other apparatus. Entire project will cost about $250,000.

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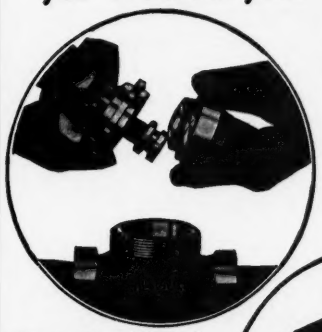

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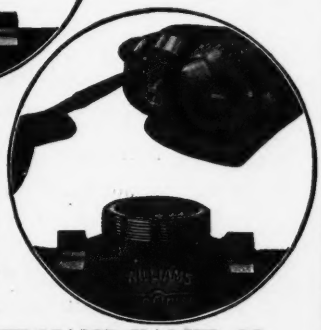

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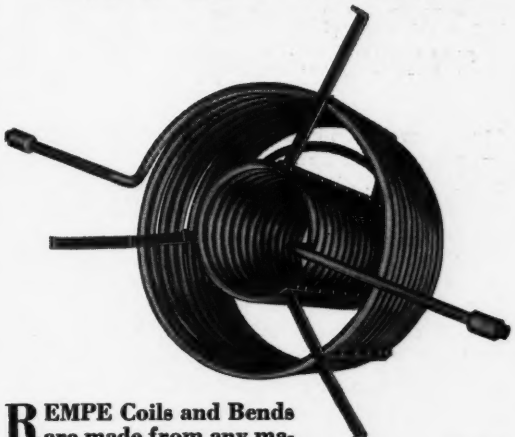

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